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Movements and Habitat Use by Hatchery-Reared Pallid Sturgeon in the Lower Platte River, Nebraska

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Movements and Habitat Use by Hatchery-Reared Pallid Sturgeon in the lower Platte River, Nebraska

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Because of its endangered species status, information on habitat requirements of pallid sturgeon *Scaphirhynchus albus* is needed for recovery efforts. The mouth of the Platte River, Nebraska has been designated as a Recovery-Priority Management Area by the Pallid Sturgeon Recovery Team, U.S. Fish and Wildlife Service. In 1998, 10 age-6 hatchery-reared pallid sturgeon were implanted with radio transmitters and released into the lower Platte River at Two Rivers State Recreation Area, Nebraska. Research continued in 1999 with implantation of 15 age-7 hatchery-reared pallid sturgeon. Movements and habitat use were assessed using airboat, river bank and aerial surveys. Movement to a distance of 20 km upstream from the release site was observed. However, the majority of fish remained between the release site and the mouth of the Platte River, a distance of approximately 65 km downstream. Most observations (85%) occurred at depths of 0.33 to 1.21 m. Mean column velocities of 0.41 to 1.00 m/s and bottom velocities less than 0.70 m/s were used at frequencies of 75% and 91%, respectively. Observations usually occurred in areas downstream of sand bars where currents converge. These habitats are unique to braided Great Plains Rivers and are most likely important to the recovery of this species.

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Introduction

Sturgeon are some of the most primitive fishes and are very important in understanding vertebrate evolution (Birstein 1993). Sturgeon and paddlefish belong to the Order Acipenseriformes, Infraclass Chondrostei. The two families, Acipenseridae and Polyodontidae, are represented by these two groups of fishes, sturgeons and paddlefishes, respectively. There are 27 acipenseriform species in Eurasia and North America and 18 of these are endangered or threatened (Birstein 1993). Most historical declines or depletions have been caused by overexploitation and habitat changes (Rochard et al. 1990). Species in the United States and Canada consist of more stable populations than those in the former Soviet Union and China. As these species are lost we will lose opportunities for understanding relationships between the ichthyofauna of two continents, Eurasia and North America, as well as an opportunity to further understand biological diversity (Birstein 1993).

Acipenseridae consists of four genera, *Acipenser*, *Huso*, *Pseudoscaphirhynchus* and *Scaphirhynchus*. These genera consist of 17, 2, 3, and 3 species, respectively. *Acipenser* includes species that occur on both continents while *Huso* and *Pseudoscaphirhynchus* are found strictly in Eurasia. *Scaphirhynchus* is found entirely in North America.

Research involving acipenseriforms is becoming common, especially in North America with *Acipenser* being the most studied. The lake sturgeon *Acipenser fulvescens* has benefited from this research in the Great Lakes and Mississippi watershed. Thuemler (1985) examined the lake sturgeon population in the Menominee River in Wisconsin and

Michigan. Auer (1996) evaluated the response of lake sturgeon as a hydroelectric facility converted from peaking to near run-of-the-river operation in the Sturgeon River, Michigan. Chiasson et al. (1997) studied the habitat use, food habits, and distribution of juvenile lake sturgeon, a life stage that is little understood, in northern Ontario rivers.

The white sturgeon *Acipenser transmontanus* and Atlantic sturgeon *Acipenser oxyrhynchus* have profited from research on the west and east coast of North America, respectively. The potential production and dynamics of populations of white sturgeon were examined in the impounded and unimpounded Lower Columbia River (Beamsderfer et al. 1995, DeVore et al. 1995). Smith (1985) summarized the fishery, biology, and management of the Atlantic sturgeon in North America. Moser and Ross (1995) reported on the habitat use and movements of Atlantic sturgeon and shortnose sturgeon *Acipenser brevirostrum* in the Lower Cape Fear River, North Carolina. The distributions of shortnose and Atlantic sturgeon in South Carolina were summarized by Collins and Smith (1997) while Collins et al. (2000) examined specific aspects of habitat use and biological characteristics of adult Atlantic sturgeon in two rivers in South Carolina.

The shortnose sturgeon is sometimes found with the Atlantic sturgeon yet its populations are somewhat more imperiled and have been more thoroughly studied. Buckley and Kynard (1985) described the yearly movements of this species in the Connecticut River. A description of the spawning habitat used by shortnose sturgeon in the Merrimack River, Massachusetts was reported by Kieffer and Kynard (1996) and more recently Kynard et al. (2000) described in detail the habitats used by shortnose sturgeon in two Massachusetts Rivers.

Scaphirhynchus is perhaps the least understood of the North American acipenseriforms consisting of three species, *S. albus*, *S. platorynchus*, and *S. suttkusi*. They are very closely related to *Pseudoscaphirhynchus* in Eurasia, an even more imperiled genus (Birstein 1993). Most of the populations are highly fragmented in comparison to Acipenser.

The pallid sturgeon *Scaphirhynchus albus* was described as a species by Forbes and Richardson (1905). It once inhabited the Missouri River with the shovelnose sturgeon *Scaphirhynchus platorynchus* in numbers suitable to sustain a commercial fishery (Keenlyne 1989). On September 6, 1990, the pallid sturgeon was listed as endangered pursuant to the federal Endangered Species Act (55 FR 36641). Although the cause of decline in its populations can be attributed to many probable factors, little is known about where this species lives and the habitats it prefers (Kallemeyn 1983, Keenlyne 1989).

Hybrids between pallid and shovelnose sturgeons have been found. Though pallid sturgeon and shovelnose sturgeon have close evolutionary relationships, genetic evaluation has supported the distinction of the two species (Campton et al. 1997, Campton et al. 2000). It is hypothesized that incomplete reproductive isolation or recently established reproductive isolation is the possible cause for such similarity between the two species (Phelps and Allendorf 1983). Hybrids tend to use habitats more similar to shovelnose sturgeon, yet their diets are more like pallid sturgeon (Carlson et al. 1985). The genetic integrity of the pallid sturgeon could be lost through hybridization with the shovelnose (Keenlyne 1989) and the occurrence of hybridization seems to

correlate with areas of altered habitats and low pallid sturgeon population densities (Schmulbach 1974).

Missouri River habitats have been modified by damming and channelization in much of the pallid sturgeon's historic range. Approximately 1,593 km of river (28% of the pallid sturgeon's range) has been impounded by main stem hydropower facilities. Approximately 2,913 km (51% of the pallid sturgeon's range) has been channelized to allow for barge traffic. The remaining 21% of the pallid sturgeon's historic range is below dams where temperature, turbidity changes and altered flows have great effect on the success of populations (Keenlyne 1989).

Other possible causes for decline can be attributed to pollutants (Keenlyne 1989) and reduction in the productivity of rivers in their range (Hesse 1987). The U.S. Fish and Wildlife Service (USFWS) suggested that the reduced availability of prey might influence sexual maturity and lengthen time between spawning periods (USFWS 1993). Sturgeon may require areas of high turbidity to feed on unsuspecting prey and with the advent of altered flows contributing to clearer water, this may become difficult (Keenlyne 1989). When main stem Missouri River reservoirs filled, commercial fishermen collected hundreds of individuals for the market (Keenlyne 1989). Kallemeyn (1983) suggested that it would be difficult to determine whether overfishing may be a cause for decline because commercial fishermen frequently did not distinguish the pallid sturgeon from the shovelnose sturgeon in their catch.

The Platte River drains 140,000 km^2 in Nebraska, Wyoming, and Colorado. Like the Missouri its flow is regulated by dams and diversions, most of which are in upstream

reaches. But unlike the Missouri its lower reaches have not been channelized and it retains the braided channels and shallow sand bar habitat of a plains river. The lower Platte River is that reach from its confluence with the Missouri River in eastern Nebraska upstream to the confluence of the Loup River at river kilometer (rkm) 162 near Columbus, Nebraska (Figure 1). It is characterized by many sand bars and flats with multiple meandering channels of deeper water. The average depth is 26 cm with less than 10% of the river more than 60 cm deep (Peters et al. 1989). The width of the river ranges from approximately 150 to 400 m and is bordered by cottonwood *Populus deltoides*, green ash *Fraxinus pennsylvanica*, silver maple *Acer saccharinum*, and eastern red cedar *Juniperus virginiana*. The dominant fish assemblage includes red shiner *Cyprinella lutrensis*, western silvery minnow *Hybognathus argyritus*, plains minnow *Hybognathus placitus*, speckled chub *Extrarius aestivalis*, flathead chub *Platygobio gracilis*, river shiner *Notropis blennius*, sand shiner *Notropis ludibundus*, river carpsucker *Carpiodes carpio*, channel catfish *Ictalurus punctatus*, freshwater drum *Aplodinotus grunniens*, and shovelnose sturgeon (Peters et al. 1989). Mean daily discharge for all records at the Louisville gauging station (rkm 26) (Figure 1) was at its lowest on September 3, 1976 at 40 m^3/s and at its highest on July 25, 1993 at 42,062 m^3/s.

Pallid sturgeon are infrequently caught by anglers in the lower Platte River every year (Darrell Feit, Nebraska Game and Parks Commission, personal communication). In addition, the mouth of the Platte River has been designated as a Recovery-Priority Management Area by the Pallid Sturgeon Recovery Team (USFWS 1993). Therefore, additional information is needed to recover the species in the lower Platte River.

My primary objective was to document habitat use by hatchery-reared pallid sturgeon in the lower Platte River. My second objective was to determine diel and seasonal movement patterns of hatchery-reared pallid sturgeon in the lower Platte River.

Methods

Fish studied. – The pallid sturgeon used in this research were spawned at Blind Pony State Fish Hatchery in Missouri in 1992. The broodstock consisted of two females and two males collected from the lower Mississippi River in Missouri and two males collected from the Missouri River in Nebraska. The juveniles were raised at Gavins Point National Fish Hatchery in South Dakota until their release into the lower Platte River at Two Rivers State Recreation Area (TRSRA) in 1998 and 1999 (Figure 1). Ten age-6 individuals were radio-tagged in 1998 (Table 1) and released with 74 other age-6 pallid sturgeon (Table 2). In 1999, 15 age-7 individuals were radio-tagged and released (Table 3). All pallid sturgeon were fitted with passive integrated transponder (PIT) and coded-wire tags.

Telemetry. – Pallid sturgeon were implanted with radio transmitters (49.014 – 49.521 MHz) equipped with whip antenna at Gavins Point National Fish Hatchery. Transmitters were implanted without anesthesia. The whip antenna from the transmitter was allowed to protrude approximately 25 cm from the single incision in 1998. A staggered entry technique was used for implantation in 1999, which allowed the whip antenna to protrude from a small hole made with a hypodermic needle lateral to the main incision. Transmitters measured 40 mm x 15 mm and weighed approximately 14.6 g out of water

and had a guaranteed battery life of 400 days. Transmitter weight was always less than 1.2% of a fish's weight. In 1998, fish were implanted on April 15 and released on April 16 at TRSRA (rkm 65). In 1999, pallid sturgeon were tagged on March 15 and released at TRSRA on April 21. This delay in 1999 allowed individuals to recover from implantation and would aid in the healing process of the incision.

Specific locations of individuals were detected using a radio receiver and loop antenna and by determining the direction of the null signal following Winter (1996). This was conducted from at least three directions to triangulate the initial position of a fish during an observation. The location was confirmed by drifting directly over the fish. Habitat measurements were then collected at that point.

Two techniques were used to determine if individual radio-tagged pallid sturgeon had dropped transmitters. The first was to use a seine and attempt to locate individuals whose signal had been located in very shallow water. Once the area was thoroughly covered with no capture the transmitter was then considered dropped. The second technique involved locating an individual's signal in the fall of 1998 and then again locating the signal in the same location during the spring of 1999.

Habitat use. – Habitats used were described using a single point over the fish along with four other points surrounding its location. These four points were located approximately 2 m upstream, 2 m downstream, 2 m to the left of the fish, and 2 m to the right of the fish and were used to describe the habitats surrounding each individual (Figure 2). Variables measured were substrate, depth, mean column velocity, bottom velocity, and instream

and/or out of stream cover. Substrate type was determined by hand grabs or probes of the bottom using a wading rod and categorized visually by % silt (<0.2 mm), % sand (0.2-2.0 mm), and % gravel (>2.0 mm). Depth was measured to the nearest 3 cm (0.1 foot) using a 1.83 m (six-foot) top set wading rod. Mean column velocity (m/s) was measured at 0.6 x depth and bottom velocity (m/s) was measured at 12 cm (0.4 feet) from the bottom using a Marsh & McBirney® current velocity meter. Instream and out of stream cover was noted in the immediate area surrounding the fish. A laser range finder was used to determine distances to either river bank and to the nearest woody debris or sand bar from each pallid sturgeon. A detailed drawing was made and a photograph was taken of the area surrounding the fish's location. Longitude and latitude were documented with each contact using a global positioning system (GPS) unit and the observation was plotted on a 7.5-min, 1:24,000 topographic map. GPS coordinates and photos were used to estimate when transmitters had dropped from tagged fish after locating individuals in the same areas during the fall of 1998 and spring of 1999. Dissolved oxygen (mg/L), temperature (°C), conductivity (μS) and specific conductivity (μS) were also recorded at each fish's location. A 1 L sample of water was collected for the determination of total suspended solids using the method described in APHA (1989).

Diel/seasonal movement. – To document diel movement and habitat use patterns of selected pallid sturgeon, biweekly 12-hour observation periods were conducted in 1998 and 1999 (Table 4). The fish was located every hour during the 12-hour period. These observation periods were chosen randomly to occur from 0800 to 2000 hours or 2000 to

0800 hours. The second observation period in the month was scheduled during the opposite time selected for the first. After a fish was located the habitat was described as above.

One observation was randomly selected from each of the 12-hour observation periods. These were used as a daily contact for the determination of general habitat use and seasonal movement in addition to the description of diel movement and habitat use patterns. These randomly selected observations were used throughout the analysis of the data.

Movement was determined from the plots of observations on the 7.5-min, 1:24,000 topographic map. Distance moved was estimated from the mid-channel location of the last observation recorded. When an individual was not located due to interference or attenuation of the radio signal, the location was left as unknown.

Data analysis. – Minimum and maximum values of habitats used were obtained using both daily contacts and all 12-hour observation data. Mean values of habitats used were calculated using daily observations and only one random observation from each 12-hour observation period. Differences in habitat variables used were conducted using analysis of variance (ANOVA) procedures. Habitat variables used between years, among individual fish within a year, and among days within a year were compared. Relationships between physical habitats used were calculated using Pearson's correlation coefficients. Habitat variables used with those gathered at the four points surrounding each radio-tagged pallid sturgeon were also compared using a pairwise t-test and critical

values of least significant differences (Fisher's LSD). Data analysis was accomplished using the Statistical Analysis System (SAS Institute 1999) and a rejection probability level of 0.05 was maintained throughout analysis.

Results and Discussion

Telemetry. - Pallid sturgeon were tracked from April 16 to October 8, 1998 and from April 21, 1999 to May 12, 2000. Incisions made in 1999 for the implanting of transmitters had healed when fish were examined as they were released 37 days after surgery. Transmitter battery life extended beyond 400 days.

In 1998, five transmitters were dropped by radio-tagged pallid sturgeon. Fish 341 and 501 were confirmed using seines over transmitter signals in shallow water. Fish 381, 441, and 461 were confirmed using locations observed in the fall of 1998 and the spring of 1999.

Habitat use. – Individual fish were located by airboat 0 – 21 times (mean 9.3) in 1998 (Table 5) and 1 – 14 times (mean 4.1) in 1999/2000 (Table 6). This resulted in a total of 162 observations (152 daily observations + 10 randomly selected observations within the 12-hour observation periods) which were used for the determination of general habitat use. Fish 124 was located once by airboat (April 28, 1999) when windy conditions on the river prevented physical habitat measurements from being collected. Physical habitat measurements were also not collected on July 14, 1999 when this individual was in water too deep for our equipment too measure. Fish 155 was also located once in high wind

(October 1, 1999) and collecting physical habitat measurements was not possible. These three additional locations were used only for the determination of movements and in the summary of chemical habitat data.

Radio-tagged pallid sturgeon were always found over sand substrate. Silt was only used as a secondary substrate to sand and two fish were found five times over a combination of sand and gravel substrates. Underwater sand dunes and ledges were frequently used by pallid sturgeon in the lower Platte River. Bramblett (1996) concluded that pallid sturgeon in the Yellowstone and upper Missouri Rivers preferred fines and sand and avoided gravel and cobble substrates. Hurley (1998) found pallid sturgeon over sand substrate 88% of the time in the middle Mississippi River. In the lower Platte River, Hofpar (1997) found shovelnose sturgeon to prefer silt to gravel and sand substrates. Quist et al. (1999), in the Kansas River, found shovelnose sturgeon over sand substrate 92% of the time.

Depths used by pallid sturgeon in the lower Platte River ranged from 0.15 to 1.68 m and averaged 0.76 m in 1998 (Table 7). In 1999/2000, depth use ranged from 0.34 to 1.89 m and averaged 0.98 m (Table 8). Depth intervals which were used greater than 10% included those between 0.33 and 1.21 m for either or both years (Figure 3). As stated above, Fish 124 was located on July 14, 1999 in water too deep for our equipment, approximately 2.25 and 2.75 m deep. This was the only incidence of an individual observed using such depths and was not part of the data used to create Figure 3, 4, and 5. Depths used were significantly different between years ($P = 0.0120$), possibly resulting from differences in discharge in 1998 and 1999. These differences in discharge may

have changed the availability of sand bar habitat thus affecting depths used. Individual fish did not use different depths between years (P = 0.1290) and depth use was not significantly different among dates within a year (P = 0.3017). This emphasizes the importance of the shallow depths behind sand bars as a habitat component used throughout the spring, summer and fall.

These depths used contrast with Bramblett (1996) who found pallid sturgeon used a mean depth of 3.30 m. Hurley (1998) found pallid sturgeon using even greater depths of between 6 and 12 m. Clancey (1990) located pallid sturgeon in the Fort Peck tailrace in Montana at depths of 1.7 to 2.7 m while depth use in the tailrace downstream from Oahe Dam on the Missouri River was 4 to 6 m in Lake Sharpe, South Dakota (Erickson 1992). In the lower Platte River, Hofpar (1997) found shovelnose sturgeon to prefer depths between 1.51 and 1.80 m. Depths used by shovelnose sturgeon in the Kansas River during winter months ranged from 0.1 to 4.6 m (Quist et al. 1999) and in the upper Mississippi River, Hurley et al. (1987) found depths used by shovelnose sturgeon to range from 1 to 10 m.

Mean column velocities used by pallid sturgeon ranged from 0.03 to 1.26 m/s and averaged 0.69 m/s in 1998 (Table 9). In 1999/2000, mean column velocities used ranged from 0.05 to 1.26 m/s and averaged 0.69 m/s (Table 10). Mean column velocity intervals which were used greater than 10% included those between 0.41 and 1.00 m/s for either or both years (Figure 4). Mean column velocities used were significantly different between years (P = 0.0391). Individual fish used different mean column velocities within a year (P = 0.0516), though it should be noted that this P – value is very close to the rejection

level of 0.05. Differences among dates within a year were highly significant (P = 0.0004). This may indicate that mean column velocities are not an important habitat component in the lower Platte River.

Pallid sturgeon in the Yellowstone River used mean column velocities of 0.14 to 1.55 m/s (mean 0.90 m/s) and in the upper Missouri River from 0.0 to 0.82 m/s (mean 0.17 m/s) (Bramblett 1996). Hofpar (1997) found that shovelnose sturgeon in the lower Platte River preferred mean column velocities of 0.61 to 0.75 m/s. Carlson et al. (1985) however found that pallid sturgeon were more numerous than shovelnose sturgeon in some areas of swift current in the Missouri and Mississippi Rivers.

In the lower Platte River, bottom velocities used by pallid sturgeon ranged from – 0.05 to 0.97 m/s and averaged 0.36 m/s in 1998 (Table 9). In 1999/2000, bottom velocities used ranged from – 0.17 to 0.88 m/s and averaged 0.40 m/s (Table 10). Negative current velocities typically correspond to areas behind underwater sand dunes where some currents are very turbulent and are moving upstream. Bottom velocity intervals which were used greater than 10% included those between 0.0 and 0.70 m/s for either or both years (Figure 5). Bottom velocities used were not significantly different between years (P = 0.4747). Individual fish used significantly different bottom velocities within a year (P = 0.0142) and bottom velocities used were significantly different among dates within a year (P = 0.0068). When values of Pearson's correlation coefficients were examined, bottom velocity had a negative linear relationship with date within year (r = - 0.27523) and was highly significant (P = 0.0008). This meant that as the year progressed, slower bottom velocities were used. Chemical habitat variables were

compared with bottom velocities to identify correlations through a year. Changes in dissolved oxygen (r = -0.04973, P = 0.5553), temperature (r = -0.09515, P = 0.2566), conductivity (r = 0.12221, P = 0.1445), and total suspended solids (r = 0.03372, P = 0.6935) were not significantly correlated to changes in bottom velocity use.

Interestingly, Bramblett (1996) found pallid sturgeon used bottom velocities ranging from 0.0 to 0.70 m/s in the upper Missouri River and Erickson (1992) found that bottom velocities used were 0.0 to 0.73 m/s in Lake Sharpe. Both of these studies recorded values very similar to those used in the lower Platte River. Shovelnose sturgeon used bottom velocities ranging from 0.35 to 0.45 m/s in the lower Platte River (Hofpar 1997) while Quist et al. (1999) found bottom velocity use ranged from 0.02 to 0.79 m/s and averaged 0.34 m/s in the Kansas River.

Most radio-tagged pallid sturgeon in the lower Platte River used areas characterized by sharp changes in depth, at the downstream edges of sand bars. Hurley (1998) found pallid sturgeon in the middle Mississippi River in main channel and main channel border areas. The sand bar areas in the lower Platte were at times adjacent to deep main channels, but fish were never found directly in the channel. Fish frequently used the same length of edge repeatedly and were found to follow and hold on this type of habitat for weeks at a time. The use of instream cover such as logs and other woody debris was negligible, though these habitats are not common in the lower Platte River. One individual, located on May 20, 1998, used a large stump as a current break and was positioned approximately 1 m from the structure. Five locations from five other individuals were positioned 10, 16, 16, 19 and 20 m downstream from woody debris.

Relationships between depths, mean column velocities, and bottom velocities used can be determined by examining Pearson's correlation coefficients. The linear relationship between depth and mean column velocity was positive, strong, and highly significant ($r = 0.50803$, $P < 0.0001$). This indicates that as depth increased, mean column velocity also increased. This seems fairly intuitive for the habitats where radio-tagged pallid sturgeon were located. However, this relationship may not hold for pools or backwater areas of the lower Platte River.

The linear relationship between depth and bottom velocity was positive, strong, and highly significant ($r = 0.23592$, $P = 0.0044$). When the linear relationship between mean column velocity and bottom velocity was examined, the relationship there was also positive, strong and highly significant ($r = 0.57269$, $P < 0.0001$). These relationships also seem intuitive for the habitats radio-ragged pallid sturgeon were using but, again, could be highly variable in other habitats found in the lower Platte River.

Measurements of habitat variables surrounding an individual were different from those at the fish's position (Figure 2). Based on significant differences in depth ($P = 0.0163$), a Fisher's protected LSD (LSD = 0.03) was then used to compare depths at the five points. Depths were greatest downstream of the fish at point 3 (mean 0.82 m). Point 4, to the left of the fish, was shallowest (mean 0.77). Points 1, 2, and 3, points 1, 2, and 5, and points 4 and 5 were grouped as not being significantly different. Based on a significant difference in mean column velocity ($P = 0.0054$), pairwise comparisons were made (LSD = 0.0277). Mean column velocities were fastest downstream of the fish at point 3 (mean 0.71 m/s) and were the slowest at point 4 (mean 0.66 m/s). Points 1, 2, and

5, points 1, 4, and 5, and points 2 and 3 were grouped as not being significantly different. Since the overall F-test for bottom velocity was not significant ($P = 0.1539$), pairwise comparisons were not made. Bottom velocities were fastest to the right of the fish at point 2 (mean 0.42 m/s). The slowest bottom velocities were upstream of the fish at point 5 (mean 0.36 m/s).

Point 1, at the fish's location, was frequently included in each grouping when examining depth and mean column velocity. This illustrates how habitats at the pallid sturgeon's location were areas of transition between surrounding habitats yet consisted of similar bottom velocities. It also confirms our suspicions about the use of sloping habitats downstream from sand bars. Areas in front of pallid sturgeon locations were ideally suited for several prey species, such as red shiners, sand shiners, river shiners, western silvery minnows, plains minnows, and speckled chubs, as can be identified through habitat suitability indices collected in the lower Platte River (Holland and Peters 1994).

Water chemistry parameters were measured over radio-tagged pallid sturgeon from May 18 to October 8, 1998 and from April 28 to October 5, 1999. Water temperature use ranged from 13.1 to 33.7 °C (mean 24.8 °C, median 26.2 °C) in 1998. In 1999, water temperature ranged from 11.4 to 30.9 °C (mean 20.6 °C, median 19.8 °C). Dissolved oxygen levels were observed as low as 6.12 mg/L in 1998 (mean 9.3 mg/L) and 4.87 mg/L in 1999 (mean 8.7 mg/L). Conductivity ranged from a low of 240 µS on September 17, 1998 to a high of 1702 µS on August 18, 1999.

Mean annual discharge was 192 m^3/s at rkm 77 (Leshara) in 1998 and 229 m^3/s in 1999. This area is downstream from the confluence of the Loup River with the Platte (Figure 1). At rkm 44 (Ashland), mean annual discharge was 266 m^3/s in 1998 and 303 m^3/s in 1999. This section is directly below the mouth of the Elkhorn River on the Platte, another important tributary (Figure 1). Mean annual discharge downstream from Salt Creek was 311 m^3/s at rkm 26 (Louisville) in 1998 and 360 m^3/s in 1999.

These flows are similar to several other important Recovery-Priority Management Areas designated by the Pallid Sturgeon Recovery Team, U.S. Fish and Wildlife Service. Mean annual discharge in the Yellowstone was 361 m^3/s for 78 years of record and mean annual discharge in the upper Missouri River in Montana was 291 m^3/s for 44 years of record, both in 1993 (Bramblett 1996). Other Recovery-Priority Management Areas however are very different with respect to discharge. Hurley et al. (1987) described the mean discharge at Lock and Dam 13 on the Mississippi River as 1,342 m^3/s and on the Missouri between Sioux City, Iowa and St. Louis, Missouri, Latka (1994) cited a mean monthly discharge of 1,200 m^3/s during the navigation season.

Diel movement. – In 1998, two 12-hour observation periods were conducted during daylight hours (0800 to 2000 hours) and one was conducted at night (2000 to 0800 hours), while in 1999, five observation periods were conducted during daylight hours and two were conducted at night (Table 4). From these 10 12-hour observation periods, 100 contacts were made with individual pallid sturgeon (Tables 5 and 6).

During 12-hour observation periods, most fish did not change their location. Fish were never observed moving location in 1998 during these periods but there were three instances of movement in 1999. Fish 075 moved across the river 346 m at 0830 hours on May 13, 1999 after it was first located at 0730 hours. This was followed with a movement downstream 75 m three hours later. These movements were observed directly upstream of the mouth of the Elkhorn River on the Platte River. Fish 174 was also found in this area within 50 m of Fish 075, holding along an edge of a sand bar approximately 1 m deep adjacent to a main channel.

On June 9, 1999, Fish 055 was first located at 0800 hours and was observed moving upstream 225 m at 1000 hours then did not move again through the 12-hours observation period. The fish was located approximately 1 km upstream of the mouth of the Elkhorn River in the Platte River and continued to use this area for several days after the 12-hour observation period.

Fish 095 was observed on July 21, 1999 moving downstream 125 m at 1620 hours. This was followed with three more movements downstream of 60, 83, and 225 m at 1820, 1920, and 2020 hours, respectively. The fish moved along a sand bar edge adjacent to the main channel. The area was approximately 9 km upstream from the mouth of the Platte River.

Individual fish were found in significantly deeper water from 0800 to 2000 hours (mean 0.72 m) then from 2000 to 0800 hours (mean 0.60 m) ($P = 0.0042$). Mean column velocity use did not differ between these two time periods ($P = 0.7452$). There were no differences in bottom velocity use ($P = 0.9195$).

It appears that once these tagged individuals found suitable habitat, movement ceased. It is unknown why individuals moved at the times recorded. Fish 075 on May 13, 1999 was observed moving when water temperatures were gradually increasing from 16.9 °C at 0730 hours to 17.9 °C at 1030 hours. On June 9, 1999, Fish 055 was also observed moving upstream as water temperatures increased from 24.5 °C at 0800 hours to 25.4 °C at 1000 hours. Similarly, on July 21, 1999 Fish 095 moved downstream as water temperatures increased from 30.3 to 30.8 °C. This occurred during four successive movements between 1620 to 2020 hours.

Dissolved oxygen and conductivity also increased at times of movement except for Fish 095. In this case, between 1620 and 1820 hours, dissolved oxygen levels decreased from 5.43 to 4.87 mg/L but increased to 5.65 mg/L by 2020 hours. It should be noted that the dissolved oxygen level of 4.87 mg/L at 1820 hours was the lowest recorded over a radio-tagged pallid sturgeon. It is possible that these low dissolved oxygen levels caused this individual to move in an attempt to find better conditions.

Seasonal movement. – Radio-tagged pallid sturgeon were located from the river bank 3 – 24 times (mean 13.2) in 1998 (Table 5) and by airplane 0 – 20 times (mean 5.7) in 1999/2000 (Table 6). The combined number of observations used to determine seasonal movement was 383 (165 observations from the water + 218 observations from the air or river bank). These observations were made from April 16 to October 8, 1998 and from April 21, 1999 to May 10, 2000.

Twenty-two of 25 radio-tagged pallid sturgeon moved downstream immediately after their release at TRSRA (rkm 65). Three fish in 1998 moved upstream approximately 500 m but soon after moved downstream. In 1999, individuals repeated this pattern but once headed downstream, typically moved much quicker over longer distances. Eight individuals hesitated in their downstream movement at the mouth of the Elkhorn River (rkm 52). Fish 055 used this area for several weeks in May, June and August 1999 (Figure 6). Fish 155 and 164 used this area also but in September - December 1999 (Figure 7). Eight individuals were also found to use the area upstream of Louisville (rkm 26), mostly during March and April. But, fish were often located here throughout the year.

Two radio-tagged pallid sturgeon moved upstream in late September 1999 (Figure 6). Fish 055 moved 20 km upstream of the release site on October 11 but soon afterwards headed downstream. This individual was last observed on November 22, 1999 at the mouth of the Platte River at rkm 1.7. By December 14, 1999 this individual's signal was lost and I assumed that it went into the Missouri. Fish 014 followed a similar pattern of movement but the distances moved were not as long (Figure 6). After spending time in the area upstream of Ashland at rkm 54.5 in September, it moved upstream to rkm 60.3. It then returned to rkm 16.5 in February 2000 but was last located on April 28, 2000 approximately 6 km upstream of TRSRA at rkm 71.4.

Movements of Fish 155 and 164 are summarized in Figure 7. These individuals followed similar movement patterns throughout 1999/2000 and spent a great amount of their time during the fall and early winter months in the vicinity of the mouth of the

Elkhorn River at rkm 52.3. During February and March both individuals were found at rkm 29.0, a frequently used section of the river. These fish were last located on May 5, 2000, where Fish 155 was found at rkm 52.1 downstream of the Elkhorn River and Fish 164 was found at rkm 31.9 upstream of Louisville.

Fish 095 frequented an area upstream of the mouth of the Platte River during August and September 1999 at rkm 14.0 and 12.0 (Figure 8). This area was adjacent to a deep channel bordering a high bank and contained a large sand bar with a long underwater ledge on its downstream end. This fish left the Platte River after October 11, 1999 when it was located near the mouth at rkm 4.2. Later, on March 31, 2000, this fish was found at rkm 26.0, returning to the Platte from the Missouri. It remained here until April 14, 2000 when continued downstream movements found it at the mouth of the Platte once again. Fish 095 was last located on May 12, 2000 at rkm 1.0 after it was located twice by airboat before the transmitter expired or it moved into the Missouri.

Fish 184 followed similar movement patterns. This individual used the area around rkm 34.7 (Figure 8). On October 25, 1999 it was found near the mouth of the Platte at rkm 11.6 where it remained until November 8, 1999, apparently moving into the Missouri River. Fish 184 also returned to the Platte on March 31, 2000 joining Fish 095 at rkm 32.0. This fish was last located by aerial survey at rkm 35.0 on April 28, 2000.

Management Implications

The key component of suitable pallid sturgeon habitat in the lower Platte River are the shallow sand bar ledges that are characteristic of very specific sites. The

importance of the mouth of the Elkhorn River and the area directly upstream of Louisville cannot be overemphasized. These areas consist of physically very diverse habitats that were used year round by radio-tagged pallid sturgeon. Continued use of levees to control high water and channel the river's flow could eventually lead to a reduction in the availability of these important sand bar habitats. It is unknown how the annual and daily fluctuations in water level contribute to daily changes in the availability of these habitats but it is certain that they have an effect on the maintenance of underwater sand bar ledges in the lower Platte River.

Summary

Because wild pallid sturgeon have been infrequently encountered in the Platte River, hatchery-reared individuals were used. I assumed that these hatchery-reared individuals would respond to the environment of the Platte River in a manner similar to wild individuals. Since these fish were propagated from wild broodstock that were collected from the middle Mississippi and lower Missouri River downstream of the Platte River this assumption seems reasonable. This is similar to the assumption made by Bradford and Gurtin (2000) in their study of habitat use by hatchery-reared razorback suckers *Xyrauchen texanus* in the lower Colorado River. Therefore, any information gathered from the study fish will be considered indicative of wild fish and additional hatchery-reared fish used for recovery efforts.

One of the objectives of the USFWS Pallid Sturgeon Recovery Plan (1993) includes the use of hatchery produced individuals to "augment existing populations".

This objective endeavors to ensure the genetic integrity of wild populations by eliminating any possibility of compromise through stocking efforts (USFWS 1993). These efforts will be monitored by establishing sampling stations in areas such as the lower Platte River.

This research has provided a baseline for the understanding of pallid sturgeon habitat needs and will improve the ability to recover the species in the lower Platte River. Water rights are a continuing issue in the Platte River drainage and with constant mitigation, protecting this species will be a challenge. Protecting sand bar habitat seems crucial for the survival of this species and other endangered or threatened species in the lower Platte River, such as the least tern *Sterna antillarum* and piping plover *Charadrius melodus*. Pallid sturgeon population numbers in the Platte River are as yet unknown, though as stated above, anglers typically catch several individuals each year (Darrell Feit, Nebraska Game and Parks Commission, personal communication). Therefore, angler awareness is important, as differentiating the two *Scaphirhynchus* species can be difficult. Research is continuing to develop habitat use comparisons between hatchery-reared and wild pallid sturgeon and to determine spawning times and locations for sturgeon in the Platte River.

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Table 1. Length, weight, and passive integrated transponder (PIT) numbers of hatchery-reared radio-tagged pallid sturgeon released in the lower Platte River, Nebraska, April 16, 1998.

Transmitter frequency (MHz)	Length (mm)	Weight (kg)	PIT
49.341	761	2.55	023 591 546
49.361	722	1.55	023 320 091
49.381	765	2.35	023 857 127
49.401	726	1.75	023 323 271
49.421	747	1.80	024 562 520
49.441	695	1.50	023 323 302
49.461	719	1.75	024 532 101
49.481	695	1.85	024 560 032
49.501	740	2.20	024 351 837
49.521	660	1.20	023 877 124

Table 2. Length, weight, and passive integrated transponder (PIT) numbers of non-study hatchery-reared pallid sturgeon released in the lower Platte River, Nebraska, April 16, 1998.

	Length (mm)	Weight (kg)	PIT		Length (mm)	Weight (kg)	PIT
1	734	2.25	024 321 071	38	584	0.90	023 862 003
2	686	1.65	024 525 551	39	518	0.40	023 848 871
3	652	1.20	024 259 818	40	540	0.75	024 326 295
4	700	1.55	024 281 260	41	612	1.05	024 088 771
5	674	1.45	023 781 639	42	566	0.70	024 577 543
6	629	0.75	024 307 268	43	515	0.55	023 783 059
7	622	0.85	023 876 040	44	600	0.50	023 853 055
8	704	1.75	023 800 122	45	526	0.45	024 326 855
9	650	1.45	024 085 256	46	514	0.40	024 538 065
10	692	1.55	023 313 827	47	574	0.95	023 551 115
11	655	1.25	024 342 256	48	591	0.75	024 008 011
12	635	1.05	023 338 000	49	580	0.65	023 585 284
13	619	1.15	024 560 258	50	568	0.65	023 596 260
14	620	1.10	023 342 894	51	579	0.75	023 530 821
15	672	1.55	024 544 036	52	622	1.30	024 343 874
16	652	1.20	023 554 120	53	594	0.80	023 127 609
17	591	0.75	024 526 069	54	557	0.70	024 026 880
18	615	1.05	024 260 078	55	602	1.15	024 551 627
19	564	0.95	023 574 372	56	600	0.90	023 780 551
20	509	0.50	023 338 768	57	574	0.95	024 090 797
21	426	0.45	023 778 059	58	591	0.70	023 598 524
22	642	1.45	024 028 820	59	579	0.75	024 547 827
23	554	0.60	024 025 328	60	520	0.70	024 027 576
24	465	0.30	023 877 536	61	611	1.00	023 326 635
25	578	0.90	023 592 580	62	561	0.75	024 544 615
26	583	1.00	024 013 551	63	527	0.45	024 533 321
27	491	0.35	024 555 584	64	555	0.70	024 026 532
28	534	0.60	023 558 348	65	515	0.40	024 546 088
29	626	1.35	023 553 360	66	559	0.50	023 607 525
30	601	0.90	024 029 624	67	471	0.30	023 599 788
31	627	1.05	023 549 363	68	528	0.55	023 513 594
32	630	1.20	024 016 118	69	449	0.25	023 376 809
33	595	0.75	024 540 573	70	508	0.40	024 380 517
34	494	0.35	024 029 520	71	491	0.55	024 320 787
35	546	0.65	024 030 059	72	495	0.35	023 861 311
36	487	0.45	023 548 575	73	512	0.40	024 052 369
37	583	1.00	024 531 345	74	311	0.10	023 582 569

Table 3. Length, weight, and passive integrated transponder (PIT) numbers of hatchery-reared radio-tagged pallid sturgeon released in the lower Platte River, Nebraska, April 21, 1999.

Transmitter frequency (MHz)	Length (mm)	Weight (kg)	PIT
49.014	730	2.10	020 369 018
49.034	710	1.30	021 841 323
49.055	710	1.75	018 542 588
49.065	760	2.20	019 592 773
49.075	770	1.70	019 343 515
49.095	800	1.90	020 882 009
49.105	760	2.10	021 772 114
49.115	730	1.85	019 801 078
49.124	770	2.20	019 343 575
49.134	750	1.95	018 528 834
49.155	800	2.45	019 821 824
49.164	730	1.85	017 792 828
49.174	730	1.70	019 579 020
49.184	720	1.85	020 332 530
49.195	720	1.50	021 774 610

Table 4. Ten 12-hour observation periods conducted in 1998 and 1999 over hatchery-reared radio-tagged pallid sturgeon in the lower Platte River.

Fish	Date	Time
49.501	May 28, 1998	0755 to 1855 hours
49.401	July 9, 1998	0800 to 1900 hours
49.481	July 23, 1998	2020 to 0720 hours
49.075	May 13, 1999	0730 to 1830 hours
49.105	May 27, 1999	2030 to 0730 hours
49.055	June 9, 1999	0800 to 1600 hours
49.055	June 25, 1999	0600 to 0900 hours
49.095	July 21, 1999	0920 to 2020 hours
49.095	August 3, 1999	2020 to 2220 hours
49.184	August 18, 1999	0915 to 2020 hours

Table 5. Summary of contacts made with hatchery-reared radio-tagged pallid sturgeon in the lower Platte River, Nebraska, 1998.

Fish	River bank	Airboat	12-hour
341	20	15	0
361	24	2	0
381	20	13	0
401	21	20	12
421	12	0	0
441	5	16	0
461	3	0	0
481	12	21	12
501	8	4	12
521	7	2	0
Total	132	93	36

Table 6. Summary of contacts made with hatchery-reared radio-tagged pallid sturgeon in the lower Platte River, Nebraska, 1999/2000.

Fish	Airboat	Airplane	12-hour
014	1	16	0
034	4	0	0
055	14	9	13
065	3	0	0
075	5	0	12
095	5	10	15
105	5	0	12
115	1	1	0
124	7[a]	0	0
134	1	0	0
155	2[b]	20	0
164	5	19	0
174	3	0	0
184	5	11	12
195	1	0	0
Total	62[c]	86	64

[a] Fish 124 was located seven times by airboat but physical habitat measurements were not collected for two of these observations.

[b] Fish 155 was located two times by airboat but physical habitat measurements were not collected for one of these observations.

[c] Hatchery-reared radio-tagged pallid sturgeon were located 62 times by airboat but physical habitat measurements were not collected for three of these observations.

Table 7. Summary of depths used by radio-tagged pallid sturgeon in the lower Platte River, Nebraska, 1998.

Fish	Minimum (m)	Maximum (m)	N observations	Mean (m)	Std Dev (m)	N observations
341	0.24	1.19	15	0.61	0.24	15
361	0.61	0.85	2	0.73	0.18	2
381	0.46	1.40	13	0.95	0.31	13
401	0.37	1.01	32	0.61	0.18	21
441	0.43	1.68	16	0.82	0.34	16
481	0.15	1.13	33	0.49	0.21	22
501	0.40	1.37	16	0.82	0.37	5
521	0.82	1.16	2	1.01	0.24	2
Total	0.15	1.68	129	0.76	0.31	96

Table 8. Summary of depths used by radio-tagged pallid sturgeon in the lower Platte River, Nebraska, 1999.

Fish	Minimum (m)	Maximum (m)	N observations	Mean (ft)	Std Dev (ft)	N observations
014	1.19	1.19	1	1.89	-	1
034	0.79	1.31	4	1.04	0.21	4
055	0.46	1.65	27	0.88	0.34	16
065	0.52	1.59	3	1.10	0.55	3
075	0.61	1.65	17	0.88	0.24	6
095	0.52	1.77	20	1.19	0.34	7
105	0.34	1.04	17	0.76	0.15	6
115	0.46	0.46	1	0.46	-	1
124	0.58	1.72	5	1.07	0.49	5
134	0.61	0.61	1	0.61	-	1
155	0.91	0.91	1	0.91	-	1
164	0.52	1.52	5	0.85	0.40	5
174	0.79	1.59	3	1.07	0.46	3
184	0.46	1.89	17	1.40	0.46	6
195	1.22	1.22	1	1.22	-	1
Total	0.34	1.89	123	0.98	0.24	66

Table 9. Summary of mean column and bottom current velocities used by radio-tagged pallid sturgeon in the lower Platte River, Nebraska, 1998.

Fish	Minimum (m/s)	Maximum (m/s)	N observations	Mean (m/s)	Std Dev (m/s)	N observations
			Mean column			
341	0.20	0.51	15	0.61	0.25	15
361	0.54	0.69	2	0.62	0.11	2
381	0.29	1.26	13	0.79	0.26	13
401	0.13	1.07	32	0.58	0.26	21
441	0.40	1.06	16	0.78	0.20	16
481	0.03	1.01	33	0.51	0.20	22
501	0.35	0.97	16	0.72	0.24	5
521	0.77	1.02	2	0.90	0.18	2
Total	0.03	1.26	129	0.69	0.25	96
			Bottom			
341	0.00	0.97	15	0.26	0.19	15
361	-0.05	0.49	2	0.22	0.38	2
381	0.06	0.92	13	0.44	0.24	13
401	-0.01	0.87	32	0.36	0.22	21
441	-0.03	0.83	16	0.42	0.28	16
481	-0.05	0.72	33	0.31	0.19	22
501	-0.02	0.73	16	0.26	0.26	5
521	0.58	0.62	2	0.60	0.03	2
Total	-0.05	0.97	129	0.36	0.23	96

Table 10. Summary of current velocities used by radio-tagged pallid sturgeon in the lower Platte River, Nebraska, 1999.

Fish	Minimum (m/s)	Maximum (m/s)	N observations	Mean (m/s)	Std Dev (m/s)	N observations
			Mean column			
014	0.48	0.48	1	0.48	-	1
034	0.35	1.19	4	0.84	0.36	4
055	0.20	1.26	27	0.80	0.28	16
065	0.42	0.96	3	0.68	0.27	3
075	0.28	1.04	17	0.74	0.27	6
095	0.05	1.08	20	0.76	0.17	7
105	0.24	0.91	17	0.51	0.25	6
115	0.56	0.56	1	0.56	-	1
124	0.41	1.02	5	0.70	0.28	5
134	0.82	0.82	1	0.82	-	1
155	0.88	0.88	1	0.88	-	1
164	0.05	1.04	5	0.67	0.40	5
174	0.58	0.88	3	0.73	0.15	3
184	0.47	0.96	17	0.77	0.14	5
195	0.43	0.43	1	0.43	-	1
Total	0.05	1.26	123	0.69	NA	65
			Bottom			
014	0.29	0.29	1	0.29	-	1
034	0.05	0.78	4	0.43	0.33	4
055	-0.03	0.88	27	0.44	0.26	16
065	0.27	0.42	3	0.36	0.08	3
075	0.07	0.81	17	0.59	0.20	6
095	-0.17	0.66	20	0.30	0.21	7
105	-0.04	0.80	17	0.30	0.30	6
115	0.23	0.23	1	0.23	-	1
124	0.20	0.76	5	0.49	0.28	5
134	0.32	0.32	1	0.32	-	1
155	0.71	0.71	1	0.71	-	1
164	0.03	0.83	5	0.35	0.36	5
174	0.34	0.65	3	0.50	0.16	3
184	0.07	0.70	17	0.54	0.12	5
195	0.17	0.17	1	0.17	-	1
Total	-0.17	0.88	123	0.40	NA	65

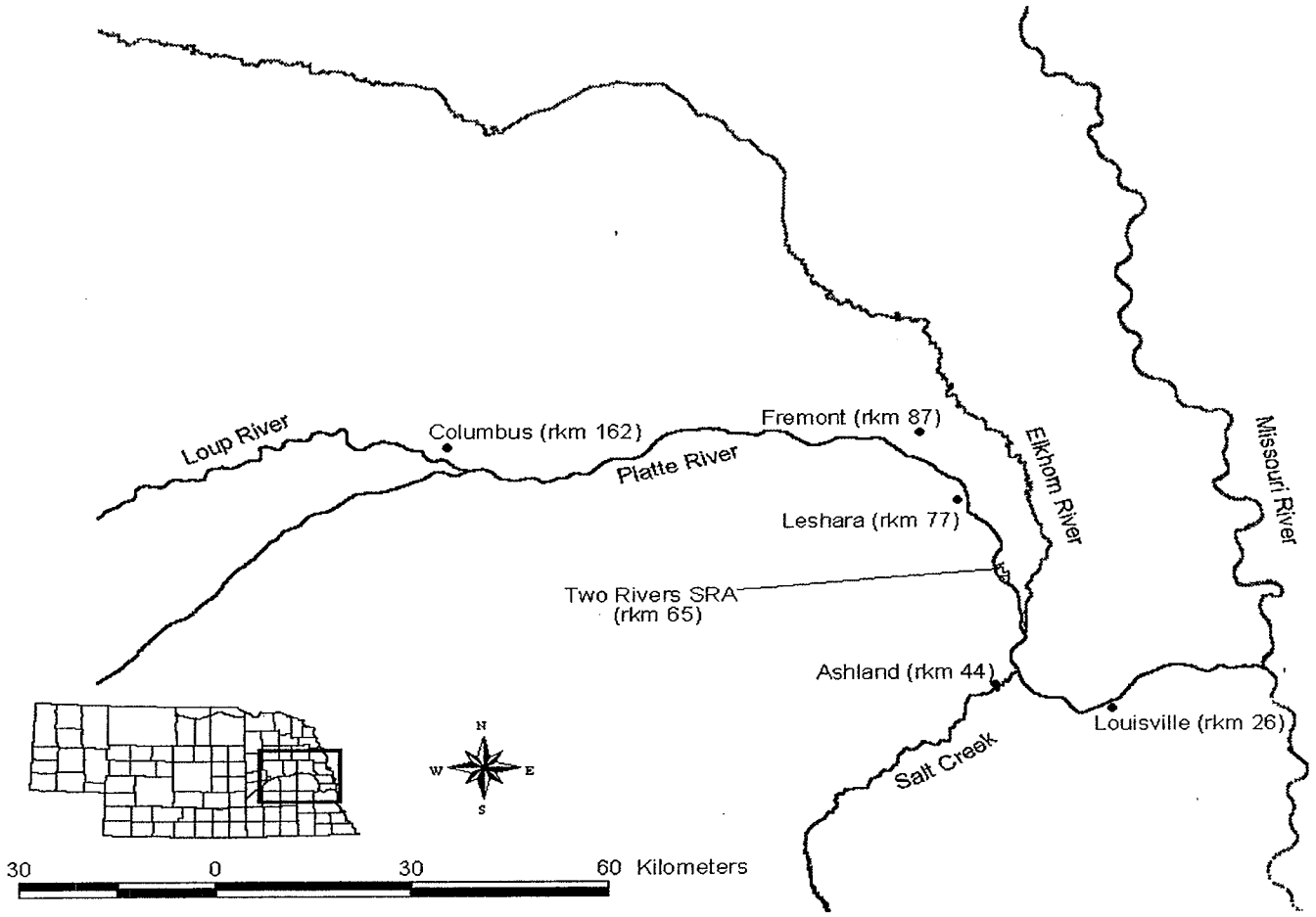

Figure 1. Map of the lower Platte River, Nebraska and major tributaries. Locations of prominent reference points and gauging stations indicated by river kilometers (rkm) from the mouth.

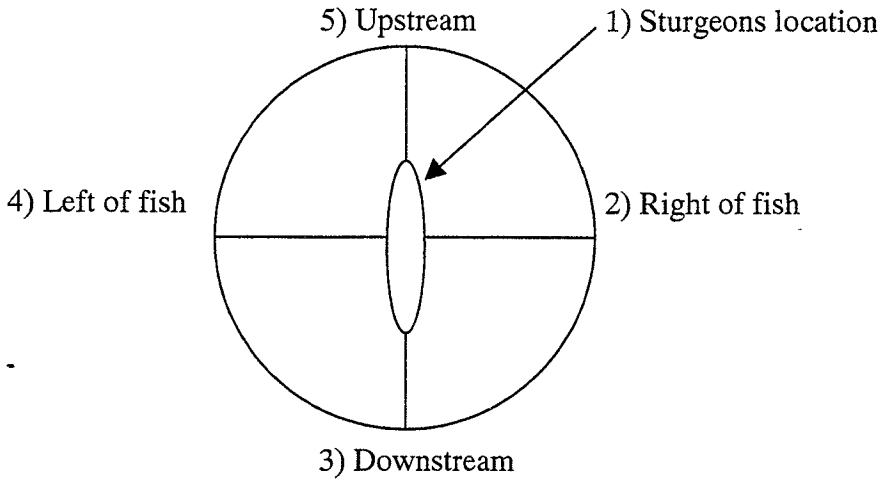

Figure 2. Five points used to describe habitats at and surrounding individual pallid sturgeon locations. Points 2-5 are approximately 2 m from point 1.

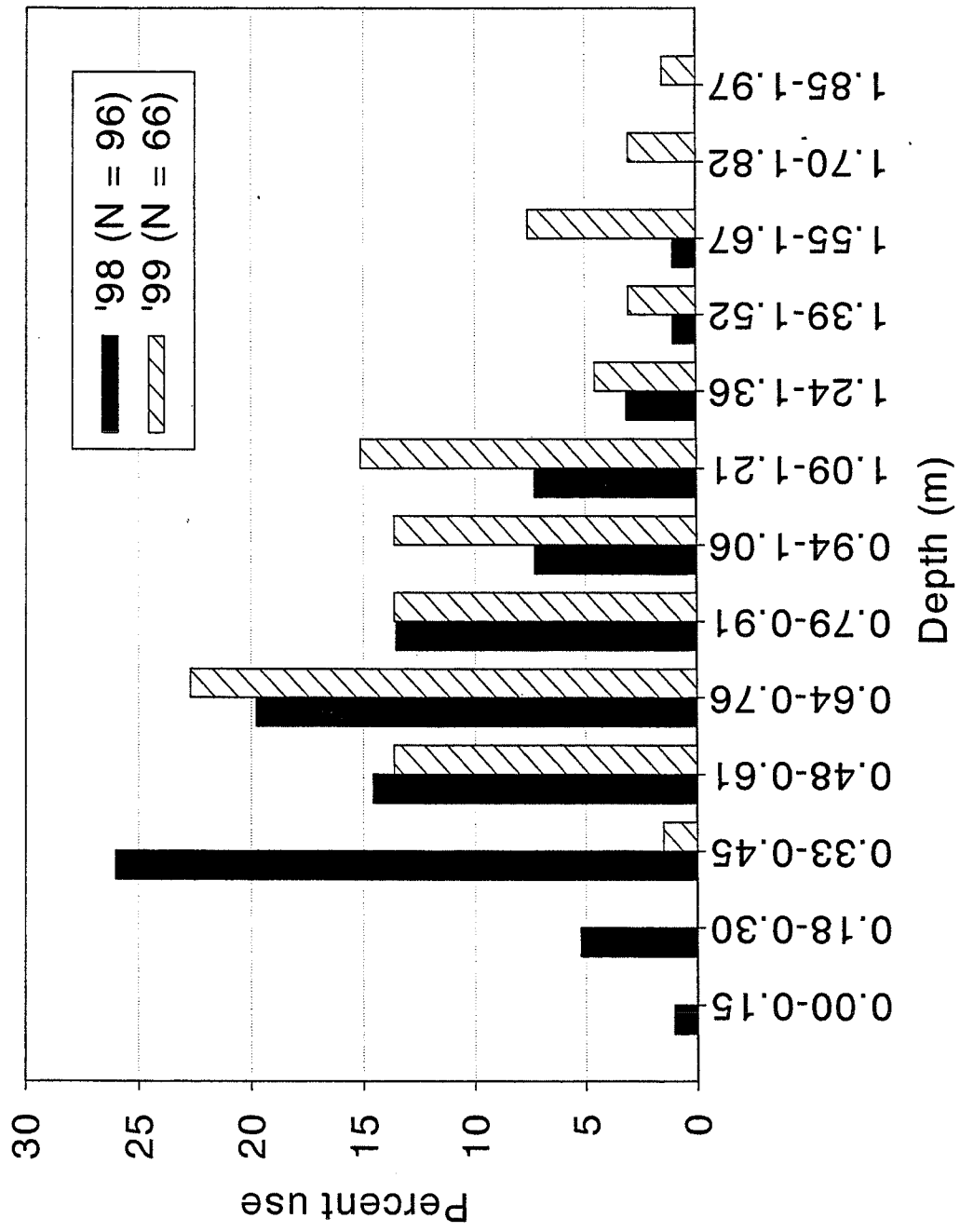

Figure 3. Percent use of depth by radio-tagged hatchery-reared pallid sturgeon in the lower Platte River

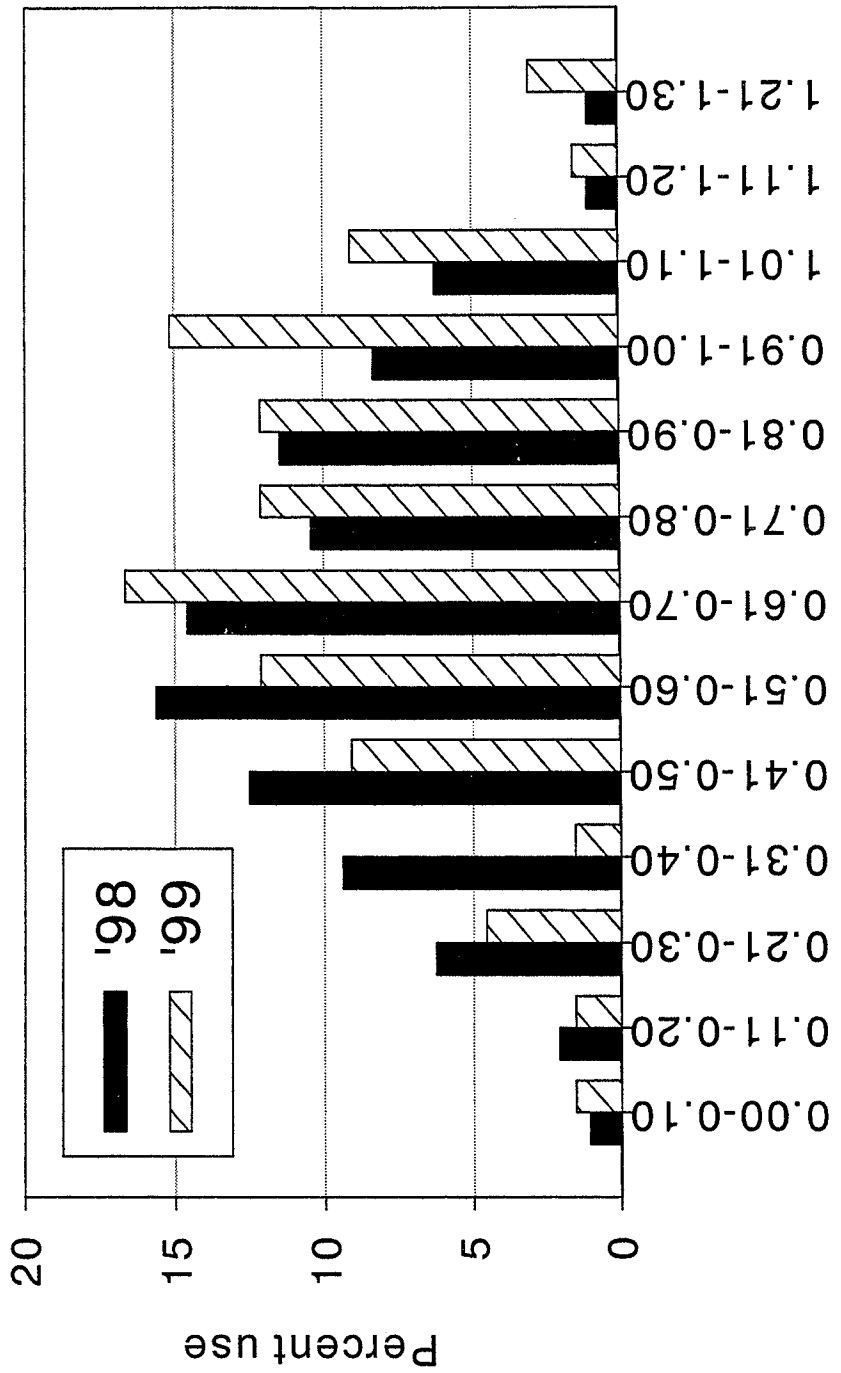

Figure 4. Percent use of mean column velocity by radio-tagged hatchery-reared pallid sturgeon in the lower Platte River.

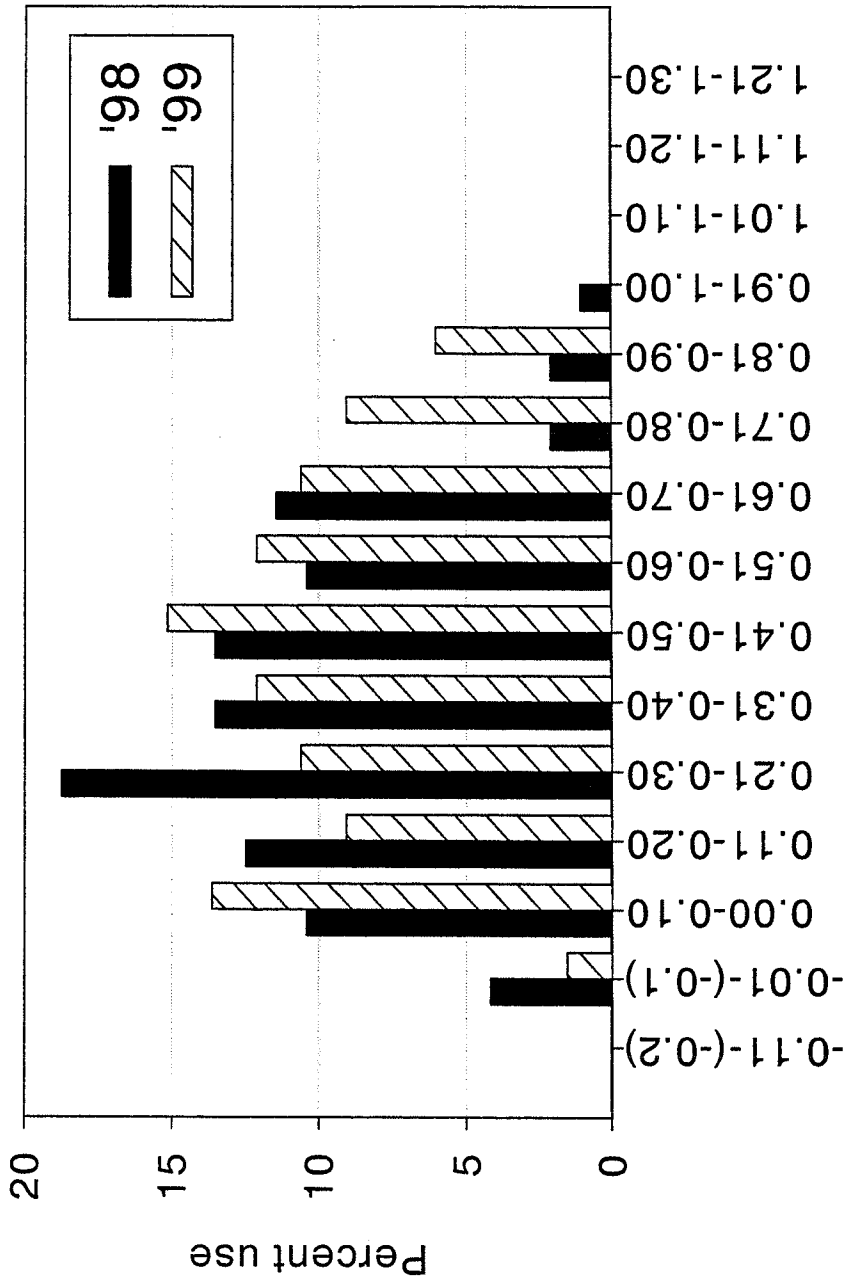

Figure 5. Percent use of bottom current velocity by radio-tagged hatchery-reared pallid sturgeon in the lower Platte River.

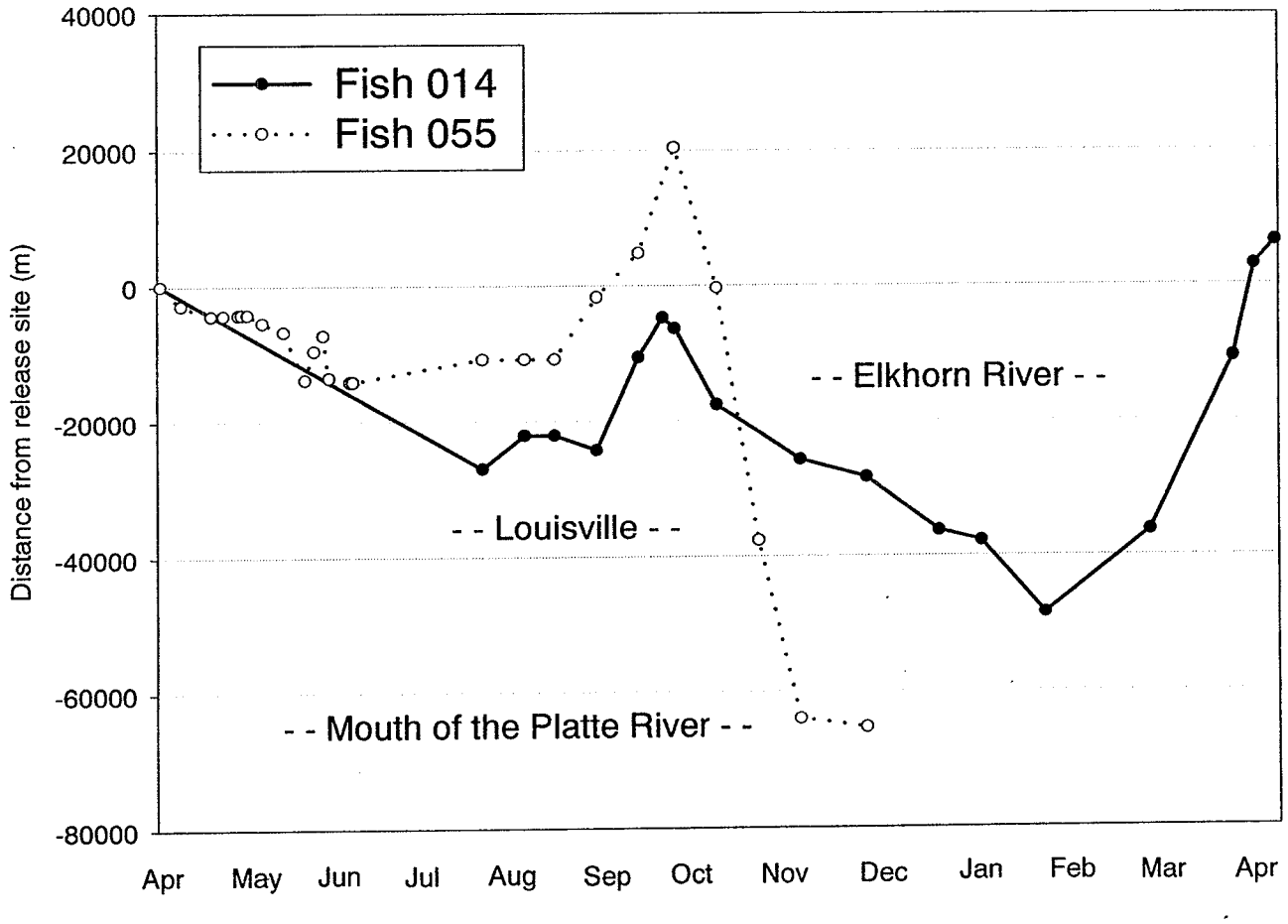

Figure 6. Movements of Fish 014 and 055 in the lower Platte River upstream (+) and downstream (-) from the release site at Two Rivers State Recreation Area (0) from April 21, 1999 to May 2, 2000

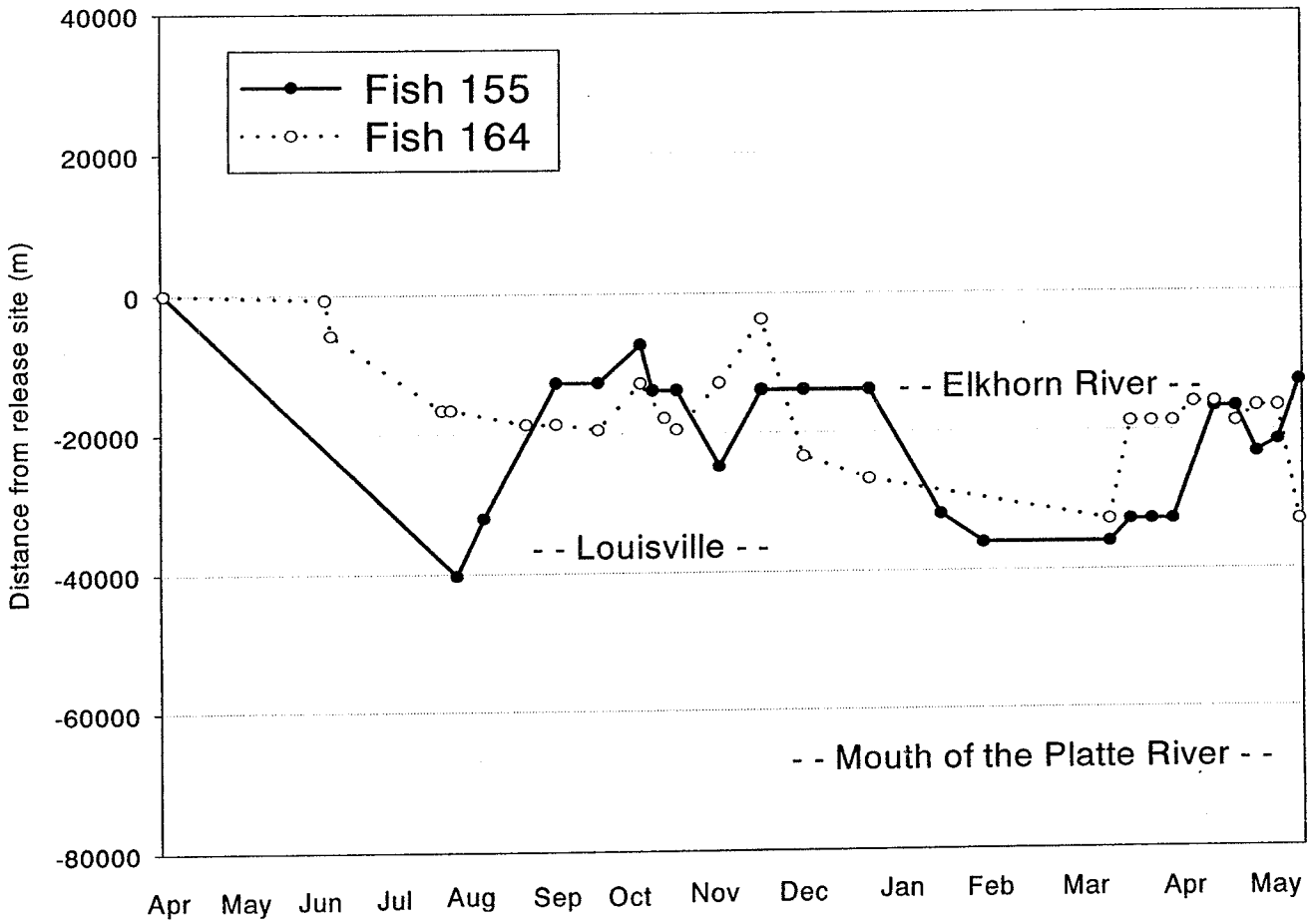

Figure 7. Movements of Fish 155 and 164 in the lower Platte River upstream (+) and downstream (-) from the release site at Two Rivers State Recreation Area (0) from April 21, 1999 to May 5, 2000

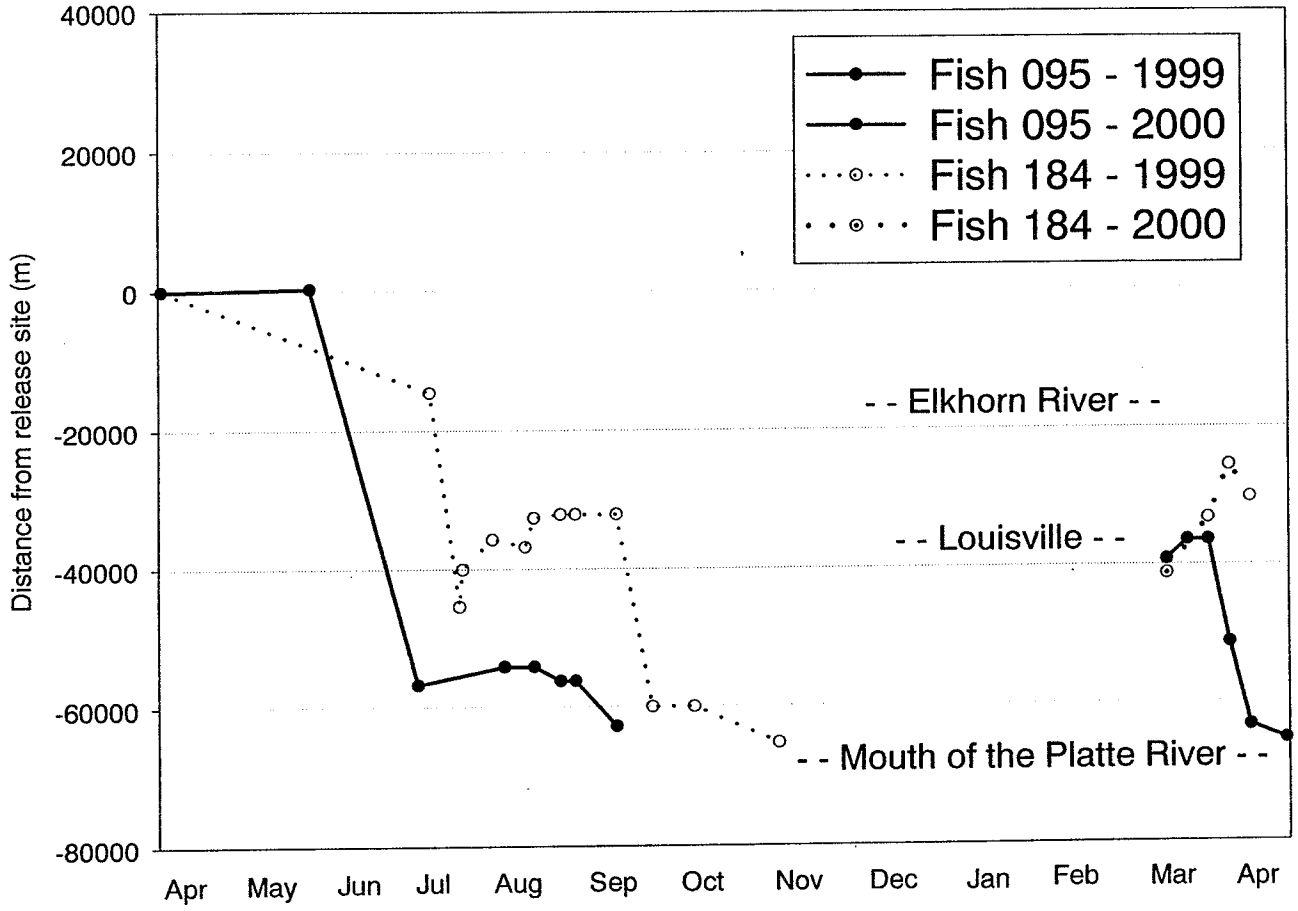

Figure 8. Movements of Fish 095 and 184 in the lower Platte River upstream (+) and downstream (-) from the release site at Two Rivers State Recreation Area (0) from April 21, 1999 to May 10, 2000

Appendix A-1. Chemical habitat data collected over Fish 014 on October 5, 1999

Date	Time (hrs)	Water temp (°C)	Dissolved oxygen (mg/L)	Conductivity (µS)	Specific Conductivity (µS)	Total suspended solids (mg/L)
Oct 5, 1999	1400	13.5	13.45	502	644	176

Appendix A-2. Physical habitat data collected over Fish 014 on October 5, 1999.

Date	Time (hrs)	GPS location	Substrate (%silt, %sand, %gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
Oct 5, 1999	1400	41 11.73N 96 19.82W	0, 100, 0	3.9	0.48	0.29

Appendix A-3. Physical habitat data collected surrounding Fish 014 on October 5, 1999.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
Oct 5, 1999	2	0, 100, 0	3.6	0.98	0.26
	3	0, 100, 0	4.2	0.50	0.39
	4	0, 100, 0	2.7	0.41	0.41
	5	0, 100, 0	3.4	0.55	0.33

Appendix A-4. Chemical habitat data collected over Fish 034 from May 17, 1999 to June 1, 1999.

Date	Time (hrs)	Water temp (°C)	Dissolved oxygen (mg/L)	Conductivity (µS)	Specific Conductivity (µS)	Total suspended solids (mg/L)
May 17, 1999	1300	18.3	9.87	762	873	180
May 18, 1999	1430	19.1	9.53	760	853	404
May 25, 1999	1030	19.2	7.87	583	654	932
June 1, 1999	1300	19.8	8.81	500	555	646

Appendix A-5. Physical habitat data collected over Fish 034 from May 17, 1999 to June 1,1999.

Date	Time (hrs)	GPS location	Substrate (%silt, %sand, %gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
May 17, 1999	1300	41 12.89N 96 21.44W	0, 100, 0	3.5	1.19	0.78
May 18, 1999	1430	41 13.07N 96 21.69W	0, 100, 0	3.3	1.00	0.60
May 25, 1999	1030	41 09.03N 96 19.09W	0, 100, 0	2.6	0.35	0.28
June 1, 1999	1300	41 06.24N 96 19.70W	0, 100, 0	4.3	0.82	0.05

Appendix A-6. Physical habitat data collected surrounding Fish 034 from May 17, 1999 to June 1, 1999.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
May 17, 1999	2	0, 100, 0	3.7	1.03	0.62
	3	0, 100, 0	4.7	1.04	0.00
	4	0, 100, 0	3.7	1.08	0.31
	5	0, 100, 0	4.0	1.11	0.65
May 18, 1999	2	0, 100, 0	4.0	1.20	0.30
	3	0, 100, 0	3.1	1.11	0.95
	4	0, 100, 0	3.6	0.93	0.06
	5	0, 100, 0	3.8	0.57	0.59
May 25, 1999	2	0, 100, 0	2.3	0.31	0.21
	3	0, 100, 0	2.7	0.45	0.32
	4	0, 100, 0	2.3	0.51	0.36
	5	0, 100, 0	2.1	0.55	0.42
June 1, 1999	2	0, 100, 0	4.7	1.08	0.54
	3	0, 100, 0	5.0	0.90	0.52
	4	0, 100, 0	5.3	1.01	-0.03
	5	0, 100, 0	4.4	0.93	0.00

Appendix A-7. Chemical habitat data collected over Fish 055 from April 28, 1999 to June 24, 1999.

Date	Time (hrs)	Water temp (°C)	Dissolved oxygen (mg/L)	Conductivity (µS)	Specific Conductivity (µS)	Total suspended solids (mg/L)
April 28, 1999	1500	11.8	10.35	425.6	569.0	66
May 8, 1999	1230	12.8	10.49	316.9	412.0	640
May 12, 1999	1200	17.5	9.30	439.7	514.0	416
May 17, 1999	1100	17.8	9.40	768.0	891.0	186
May 18, 1999	1315	18.7	9.77	760.0	864.0	226
May 20, 1999	1300	19.1	8.67	697.0	785.0	254
May 25, 1999	1130	19.7	7.98	612.0	680.0	868
June 1, 1999	1445	19.8	8.65	471.0	522.0	738
June 8, 1999	1045	25.4	8.05	494.2	490.5	1000
June 11, 1999	1215	21.8	7.99	652.0	695.0	528
June 14, 1999	1130	22.5	7.72	612.0	643.0	568
June 16, 1999	1200	18.3	9.00	541.0	621.0	428
June 23, 1999	0945	22.1	9.03	570.0	602.0	228
June 24, 1999	1100	25.2	7.98	646.0	643.0	636

Appendix A-8. Physical habitat data collected over Fish 055 from April 28, 1999 to June 24, 1999.

Date	Time (hrs)	GPS location	Substrate (%silt, %sand, %gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
April 28, 1999	1500	41 12.09N 96 20.39W	0, 100, 0	2.2	0.90	0.48
May 8, 1999	1230	41 11.57N 96 19.56W	0, 100, 0	3.8	0.52	0.1
May 12, 1999	1200	41 11.98N 96 20.16W	0, 100, 0	1.7	0.80	0.70
May 17, 1999	1100	41 11.81N 96 19.95W	0, 100, 0	3.4	1.02	0.88
May 18, 1999	1315	41 11.88N 96 20.11W	0, 100, 0	5.4	0.91	0.49
May 20, 1999	1300	41 11.91N 96 20.06W	0, 100, 0	3.6	0.97	0.63
May 25, 1999	1130	41 11.79N 96 19.91W	0, 100, 0	2.8	1.23	0.37
June 1, 1999	1445	41 11.30N 96 19.59W	0, 100, 0	2.5	0.20	0.34
June 8, 1999	1045	41 07.41N 96 18.89W	0, 100, 0	4.4	0.47	0.26
June 11, 1999	1215	41 09.52N 96 19.29W	0, 100, 0	1.6	0.59	-0.02
June 14, 1999	1130	41 10.60N 96 19.33W	0, 100, 0	3.2	0.67	0.36
June 16, 1999	1200	41 07.74N 96 19.13W	0, 100, 0	2.1	0.79	0.38
June 23, 1999	0945	41 07.31N 96 18.66W	0, 100, 0	1.8	0.78	0.19
June 24, 1999	1100	41 07.22N 96 18.66W	0, 100, 0	2.3	1.26	0.81

Appendix A-9. Physical habitat data collected surrounding Fish 055 from April 28, 1999 to June 24, 1999.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
April 28, 1999	2	0, 100, 0	2.5	1.72	1.26
	3	0, 100, 0	2.3	0.95	0.68
	4	0, 100, 0	3.0	0.82	-0.10
	5	0, 100, 0	1.9	0.88	0.73
May 8, 1999	2	0, 100, 0	3.9	0.94	0.73
	3	0, 100, 0	4.5	0.62	0.54
	4	0, 100, 0	3.0	0.43	0.19
	5	0, 100, 0	3.0	0.43	0.19
May 12, 1999	2	0, 100, 0	1.6	0.52	0.41
	3	0, 100, 0	1.2	0.88	0.84
	4	0, 100, 0	1.6	0.52	0.47
	5	0, 100, 0	1.6	0.68	0.48
May 17, 1999	2	0, 100, 0	2.0	1.13	0.93
	3	0, 100, 0	1.9	1.16	1.02
	4	0, 100, 0	2.7	0.87	-0.10
	5	0, 100, 0	3.4	0.71	0.06
May 18, 1999	2	0, 100, 0	4.8	0.89	0.45
	3	0, 100, 0	3.9	1.03	0.86
	4	0, 100, 0	4.5	1.05	0.43
	5	0, 100, 0	5.3	0.81	0.40
May 20, 1999	2	0, 100, 0	3.4	1.22	0.43
	3	0, 100, 0	3.7	0.89	0.64
	4	0, 100, 0	2.8	1.03	1.05
	5	0, 100, 0	4.1	1.01	0.10

Appendix A-9. Continued.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
May 25, 1999	2	0, 100, 0	2.1	1.08	0.72
	3	0, 100, 0	2.9	1.24	0.81
	4	0, 100, 0	2.3	1.14	0.92
	5	0, 100, 0	2.5	1.26	0.64
June 1, 1999	2	0, 100, 0	2.6	0.12	0.02
	3	0, 100, 0	3.0	0.31	0.24
	4	0, 100, 0	3.0	0.53	0.29
	5	0, 100, 0	0.9	0.56	0.43
June 8, 1999	2	0, 100, 0	4.0	0.60	0.53
	3	0, 100, 0	4.4	0.46	0.27
	4	0, 100, 0	2.5	0.06	0.00
	5	0, 100, 0	4.6	0.55	0.39
June 11, 1999	2	0, 100, 0	1.3	0.69	0.64
	3	0, 100, 0	1.0	0.78	0.63
	4	0, 100, 0	1.6	0.45	-0.09
	5	0, 100, 0	1.7	0.79	0.11
June 14, 1999	2	0, 100, 0	3.7	0.63	0.41
	3	0, 100, 0	3.2	0.56	0.28
	4	0, 100, 0	1.8	0.56	0.44
	5	0, 100, 0	2.7	0.56	0.36
June 16, 1999	2	0, 100, 0	1.7	0.80	0.12
	3	0, 100, 0	1.8	0.80	0.52
	4	0, 100, 0	1.8	0.65	0.54
	5	0, 100, 0	1.8	0.75	0.66

Appendix A-9. Continued.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
June 23, 1999	2	0, 100, 0	2.2	0.78	0.51
	3	0, 100, 0	5.0	0.12	0.03
	4	0, 100, 0	2.0	0.98	0.04
	5	0, 100, 0	1.7	0.92	0.64
June 24, 1999	2	0, 100, 0	2.5	1.04	0.83
	3	0, 100, 0	2.5	1.13	0.22
	4	0, 100, 0	2.3	1.34	0.93
	5	0, 100, 0	2.4	1.12	0.43

Appendix A-10. Chemical habitat data collected over Fish 065 from April 28, 1999 to May 25, 1999.

Date	Time (hrs)	Water temp (°C)	Dissolved oxygen (mg/L)	Conductivity (µS)	Specific Conductivity (µS)	Total suspended solids (mg/L)
April 28, 1999	1530	12.2	10.26	428.1	566.0	56
May 20, 1999	1230	19.1	8.58	676.0	765.0	298
May 25, 1999	1000	19.0	7.99	625.0	708.0	668

Appendix A-11. Physical habitat data collected over Fish 065 from April 28, 1999 to May 25, 1999.

Date	Time (hrs)	GPS location	Substrate (%silt, %sand, %gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
April 28, 1999	1530	41 12.26N 96 20.68W	0, 100, 0	1.7	0.96	0.42
May 20, 1999	1230	41 07.31N 96 18.70W	0, 100, 0	4.0	0.66	0.27
May 25, 1999	1000	41 07.03N 96 18.73W	0, 100, 0	5.2	0.42	0.38

Appendix A-12. Physical habitat data collected surrounding Fish 065 from April 28, 1999 to May 25, 1999.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
April 28, 1999	2	0, 100, 0	1.4	1.03	0.37
	3	0, 100, 0	1.4	1.05	0.87
	4	0, 100, 0	2.4	0.84	0.48
	5	0, 100, 0	2.0	0.95	0.56
May 20, 1999	2	0, 100, 0	3.3	0.80	0.65
	3	0, 100, 0	3.3	0.77	0.69
	4	0, 100, 0	3.8	0.85	0.10
	5	0, 100, 0	3.5	0.91	0.61
May 25, 1999	2	0, 100, 0	5.9	0.43	0.24
	3	0, 100, 0	6.0	0.42	0.03
	4	0, 100, 0	4.1	0.45	0.11
	5	0, 100, 0	4.2	0.51	0.37

Appendix A-13. Chemical habitat data collected over Fish 075 from April 28, 1999 to May 25, 1999.

Date	Time (hrs)	Water temp (°C)	Dissolved oxygen (mg/L)	Conductivity (µS)	Specific Conductivity (µS)	Total suspended solids (mg/L)
April 28, 1999	1530	12.2	10.26	428.1	566.0	56
May 20, 1999	1230	19.1	8.58	676.0	765.0	298
May 25, 1999	1000	19.0	7.99	625.0	708.0	668

Appendix A-14. Physical habitat data collected over Fish 075 from April 28, 1999 to May 25, 1999.

Date	Time (hrs)	GPS location	Substrate (%silt, %sand, %gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
April 28, 1999	1400	41 10.70N 96 19.37W	0, 100, 0	2.0	0.56	0.40
May 12, 1999	1030	41 07.45N 96 18.80W	0, 100, 0	2.9	1.04	0.81
May 17, 1999	1000	41 07.35N 96 18.92W	0, 100, 0	3.9	0.91	0.67
May 20, 1999	1200	41 07.26N 96 18.80W	0, 100, 0	2.1	0.28	0.30
May 25, 1999	1300	41 06.23N 96 19.62W	0, 100, 0	3.1	0.83	0.74

Appendix A-15. Physical habitat data collected surrounding Fish 075 from April 28, 1999 to May 25, 1999.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
April 28, 1999	2	0, 100, 0	1.5	0.71	0.64
	3	0, 100, 0	1.4	0.66	0.64
	4	0, 100, 0	1.9	0.30	-0.03
	5	0, 100, 0	1.1	0.72	0.75
May 12, 1999	2	0, 100, 0	2.6	0.91	0.70
	3	0, 100, 0	3.3	0.89	0.05
	4	0, 100, 0	2.8	0.98	0.58
	5	0, 100, 0	3.0	0.76	0.64
May 17, 1999	2	0, 100, 0	5.0	0.99	0.12
	3	0, 100, 0	3.8	1.08	0.91
	4	0, 100, 0	4.2	1.20	0.64
	5	0, 100, 0	4.5	0.75	0.50
May 20, 1999	2	0, 100, 0	0.8	0.17	0.12
	3	0, 100, 0	2.4	0.37	0.36
	4	0, 100, 0	2.2	0.44	0.34
	5	0, 100, 0	1.7	0.14	0.19
May 25, 1999	2	0, 100, 0	3.3	0.55	0.33
	3	0, 100, 0	3.1	0.73	0.74
	4	0, 100, 0	3.2	0.75	0.67
	5	0, 100, 0	4.9	0.70	0.05

Appendix A-16. Chemical habitat data collected over Fish 095 from June 16, 1999 to May 12, 2000.

Date	Time (hrs)	Water temp (°C)	Dissolved oxygen (mg/L)	Conductivity (µS)	Specific Conductivity (µS)	Total suspended solids (mg/L)
June 16, 1999	1415	18.7	8.95	610.0	694.0	302
July 22, 1999	1030	29.6	6.25	728.0	669.0	NA
Sept 8, 1999	1215	23.2	12.63	632.0	654.0	214
May 11, 2000	1150	21.8	9.94	492.0	521.0	194
May 12, 2000	1055	20.5	8.97	578.0	637.0	317

Appendix A-17. Physical habitat data collected over Fish 095 from June 16, 1998 to May 12, 2000.

Date	Time (hrs)	GPS location	Substrate (%silt, %sand, %gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
June 16, 1999	1415	41 13.56N 96 21.75W	0, 100, 0	2.3	0.61	0.50
July 22, 1999	1030	41 03.65N 95 57.94W	0, 100, 0	5.8	0.67	0.42
Sept 8, 1999	1215	NA	0, 100, 0	4.4	0.67	0.08
May 11, 2000	1150	41 03.47N 95 53.29W	0, 100, 0	3.8	0.92	0.43
May 12, 2000	1055	41 03.46N 95 53.27W	0, 100, 0	3.4	1.08	0.05

Appendix A-18. Physical habitat data collected surrounding Fish 095 from June 16, 1999 to May 12, 2000.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
June 16, 1999	2	0, 100, 0	2.0	0.71	0.50
	3	0, 100, 0	2.0	0.77	0.61
	4	0, 100, 0	2.3	0.45	0.39
	5	0, 100, 0	2.0	0.67	0.53
July 22, 1999	2	0, 100, 0	5.9	0.72	0.41
	3	0, 100, 0	5.9	0.58	0.00
	4	0, 100, 0	5.4	0.40	0.01
	5	0, 100, 0	5.4	0.47	0.30
Sept 8, 1999	2	0, 100, 0	3.2	0.72	0.50
	3	0, 100, 0	4.9	0.68	0.39
	4	0, 100, 0	4.4	0.76	0.28
	5	0, 100, 0	4.4	0.70	0.24
May 11, 2000	2	0, 100, 0	3.9	0.53	0.27
	3	0, 100, 0	3.8	0.90	0.63
	4	0, 100, 0	3.8	0.32	0.23
	5	0, 100, 0	4.3	0.77	0.50
May 12, 2000	2	0, 100, 0	3.8	0.90	0.05
	3	0, 100, 0	4.9	1.20	0.12
	4	0, 100, 0	3.5	1.04	0.11
	5	0, 100, 0	3.3	0.90	0.11

Appendix A-19. Chemical habitat data collected over Fish 105 from May 8, 1999 to May 25, 1999.

Date	Time (hrs)	Water temp (°C)	Dissolved oxygen (mg/L)	Conductivity (µS)	Specific Conductivity (µS)	Total suspended solids (mg/L)
May 8, 1999	1400	14.5	10.18	329.3	412.2	680
May 12, 1999	1300	18.8	9.35	463.0	525.0	328
May 17, 1999	1215	18.1	9.74	732.0	842.0	252
May 20, 1999	1340	19.1	8.35	720.0	810.0	228
May 25, 1999	1100	19.5	7.94	628.0	703.0	716

Appendix A-20. Physical habitat data collected over Fish 105 from May 8, 1999 to May 25, 1999.

Date	Time (hrs)	GPS location	Substrate (%silt, %sand, %gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
May 8, 1999	1400	41 13.39N 96 21.60W	0, 100, 0	2.4	0.26	0.06
May 12, 1999	1300	41 13.41N 96 21.60W	0, 100, 0	2.0	0.54	0.41
May 17, 1999	1215	41 12.92N 96 21.34W	0, 100, 0	3.4	0.91	0.80
May 20, 1999	1340	41 12.68N 96 21.34W	0, 100, 0	2.4	0.24	0.13
May 25, 1999	1100	41 11.86N 96 20.10W	0, 100, 0	2.4	0.61	0.00

Appendix A-21. Physical habitat data collected surrounding Fish 105 from May 8, 1999 to May 25, 1999.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
May 8, 1999	2	0, 100, 0	0.9	1.00	0.93
	3	0, 100, 0	1.0	0.96	0.94
	4	0, 100, 0	1.5	0.85	0.24
	5	0, 100, 0	1.2	1.02	0.93
May 12, 1999	2	0, 100, 0	2.0	0.65	0.12
	3	0, 100, 0	2.0	0.75	0.50
	4	0, 100, 0	1.1	0.68	0.25
	5	0, 100, 0	2.0	0.72	0.43
May 17, 1999	2	0, 100, 0	2.7	1.10	0.93
	3	0, 100, 0	2.6	0.98	0.77
	4	0, 100, 0	2.7	0.70	0.65
	5	0, 100, 0	3.8	0.88	0.37
May 20, 1999	2	0, 100, 0	2.3	0.24	0.16
	3	0, 100, 0	3.0	0.33	0.18
	4	0, 100, 0	2.4	0.18	0.13
	5	0, 100, 0	2.0	0.24	0.19
May 25, 1999	2	0, 100, 0	2.2	0.68	0.30
	3	0, 100, 0	2.2	1.01	0.93
	4	0, 100, 0	1.6	0.98	0.65
	5	0, 100, 0	2.7	1.17	1.01

Appendix A-22. Chemical habitat data collected over Fish 115 on July 19, 1999.

Date	Time (hrs)	Water temp (°C)	Dissolved oxygen (mg/L)	Conductivity (µS)	Specific Conductivity (µS)	Total suspended solids (mg/L)
July 19, 1999	1030	26.5	8.47	783.0	761.0	222

Appendix A-23. Physical habitat data collected over Fish 115 on July 17, 1999.

Date	Time (hrs)	GPS location	Substrate (%silt, %sand, %gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
July 19, 1999	1030	41 03.13N 95 59.52W	0, 100, 0	1.5	0.56	0.23

Appendix A-24. Physical habitat data collected surrounding Fish 115 on July 19, 1999.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
July 19, 1999	2	0, 100, 0	1.4	0.64	0.57
	3	0, 100, 0	1.6	0.59	0.26
	4	0, 100, 0	1.5	0.63	0.56
	5	0, 100, 0	1.3	0.76	0.65

Appendix A-25. Chemical habitat data collected over Fish 124 from May 8, 1999 to July 14, 1999.

Date	Time (hrs)	Water temp (°C)	Dissolved oxygen (mg/L)	Conductivity (µS)	Specific Conductivity (µS)	Total suspended solids (mg/L)
May 8, 1999	1330	13.9	10.07	329.2	419.4	644
June 1, 1999	1415	19.8	8.74	466.0	517.0	666
June 23, 1999	1315	24.1	10.03	630.0	641.0	200
July 7, 1999	0815	26.7	6.59	725.0	702.0	378
July 13, 1999	0900	23.5	7.34	622.0	641.0	478
July 14, 1999	0900	24.5	7.86	840.0	849.0	284

Appendix A-26. Physical habitat data collected over Fish 124 from May 8, 1999 to July 13, 1999.

Date	Time (hrs)	GPS location	Substrate (%silt, %sand, %gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
May 8, 1999	1330	41 12.87N 96 21.32W	0, 100, 0	2.6	0.94	0.76
June 1, 1999	1415	41 10.89N 96 19.23W	0, 100, 0	5.0	0.45	0.20
June 23, 1999	1315	41 02.18N 96 18.70W	0, 100, 0	1.9	0.66	0.54
July 7, 1999	0815	41 02.60N 96 06.83W	0, 100, 0	2.6	1.02	0.76
July 13, 1999	0900	41 00.28N 96 11.11W	0, 100, 0	5.6	0.41	0.20

Appendix A-27. Physical habitat data collected surrounding Fish 124 from May 8, 1999 to July 13, 1999.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
May 8, 1999	2	0, 100, 0	2.0	0.80	0.68
	3	0, 100, 0	2.6	0.92	0.79
	4	0, 100, 0	2.8	0.71	0.19
	5	0, 100, 0	2.5	0.73	0.74
June 1, 1999	2	0, 100, 0	4.2	0.33	0.03
	3	0, 100, 0	4.9	0.56	0.53
	4	0, 100, 0	4.8	0.58	0.16
	5	0, 100, 0	4.4	0.38	0.30
June 23, 1999	2	0, 100, 0	2.0	0.78	0.53
	3	0, 100, 0	1.6	0.83	0.76
	4	0, 100, 0	3.5	0.65	0.36
	5	0, 100, 0	1.8	0.70	0.20
July 7, 1999	2	0, 100, 0	2.9	0.84	0.62
	3	0, 100, 0	2.6	0.96	0.93
	4	0, 100, 0	2.7	1.13	0.90
	5	0, 100, 0	3.2	0.80	-0.03
July 13, 1999	2	0, 100, 0	3.7	0.82	0.65
	3	0, 100, 0	4.9	0.67	0.35
	4	0, 100, 0	4.2	0.72	0.38
	5	0, 100, 0	4.0	0.80	0.28

Appendix A-28. Chemical habitat data collected over Fish 134 on June 16, 1999.

Date	Time (hrs)	Water temp (°C)	Dissolved oxygen (mg/L)	Conductivity (µS)	Specific Conductivity (µS)	Total suspended solids (mg/L)
June 16, 1999	1300	18.4	8.8	550.0	629.0	354

Appendix A-29. Physical habitat data collected over Fish 134 on June 16, 1999.

Date	Time (hrs)	GPS location	Substrate (%silt, %sand, %gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
June 16, 1999	1300	41 09.86N 96 19.11W	0, 100, 0	2.0	0.82	0.32

Appendix A-30. Physical habitat data collected surrounding Fish 134 on June 16, 1999.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
June 16, 1999	2	0, 100, 0	3.4	0.73	0.56
	3	0, 100, 0	3.0	0.43	0.07
	4	0, 100, 0	2.3	0.64	0.15
	5	0, 100, 0	2.8	0.71	-0.05

Appendix A-31. Chemical habitat data collected over Fish 155 from July 28, 1999 to October 1, 1999.

Date	Time (hrs)	Water temp (°C)	Dissolved oxygen (mg/L)	Conductivity (µS)	Specific Conductivity (µS)	Total suspended solids (mg/L)
July 28, 1999	0915	29.5	6.75	838.0	772.0	772
Oct 1, 1999	1100	14.2	9.72	550.0	693.0	693

Appendix A-32. Physical habitat data collected over Fish 155 from July 28, 1999 to October 1, 1999.

Date	Time (hrs)	GPS location	Substrate (%silt, %sand, %gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
July 28, 1999	0915	41 00.85N 96 08.87W	0, 100, 0	3.0	0.88	0.71
Oct 1, 1999	1100	41 07.00N 96 18.79W	NA	NA	NA	NA

Appendix A-33. Physical habitat data collected surrounding Fish 155 on July 28, 1999.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
July 28, 1999	2	0, 100, 0	2.2	0.78	0.65
	3	0, 100, 0	4.0	0.88	0.61
	4	0, 100, 0	3.8	0.85	0.42
	5	0, 100, 0	3.3	0.66	0.37

Appendix A-34. Chemical habitat data collected over Fish 164 from June 14, 1999 to Oct 5, 1999.

Date	Time (hrs)	Water temp (°C)	Dissolved oxygen (mg/L)	Conductivity (µS)	Specific Conductivity (µS)	Total suspended solids (mg/L)
June 14, 1999	1245	23.1	8.09	623.0	647.0	604
June 16, 1999	1330	18.4	9.08	583.0	666.0	400
July 23, 1999	0845	29.3	5.88	585.0	641.0	726
July 26, 1999	0930	29.3	6.04	606.0	560.0	454
Oct 5, 1999	1445	13.9	13.72	515.0	654.0	172

Appendix A-35. Physical habitat data collected over Fish 164 from June 14, 1999 to Oct 5, 1999.

Date	Time (hrs)	GPS location	Substrate (%silt, %sand, %gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
June 14, 1999	1245	41 13.25N 96 21.76W	0, 100, 0	2.4	1.04	0.83
June 16, 1999	1330	41 11.33N 96 19.65W	0, 100, 0	2.1	0.70	0.26
July 23, 1999	0845	41 05.24N 96 20.36W	0, 100, 0	2.6	0.05	0.03
July 26, 1999	0930	41 05.23N 96 20.41W	0, 100, 0	1.7	0.57	0.03
Oct 5, 1999	1445	41 05.34N 96 20.45W	0, 100, 0	5.0	1.00	0.61

Appendix A-36. Physical habitat data collected surrounding Fish 164 from June 14, 1999 to October 5, 1999.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
June 14, 1999	2	0, 100, 0	2.5	0.94	0.54
	3	0, 100, 0	2.6	1.11	0.04
	4	0, 100, 0	2.6	0.94	0.64
	5	0, 100, 0	2.6	0.92	0.58
June 16, 1999	2	0, 100, 0	1.4	0.82	0.72
	3	0, 100, 0	1.5	1.03	0.91
	4	0, 100, 0	1.8	0.83	0.70
	5	0, 100, 0	2.1	0.72	0.56
July 23, 1999	2	0, 100, 0	3.0	0.20	0.14
	3	0, 100, 0	2.6	0.24	0.03
	4	0, 100, 0	2.3	0.00	-0.01
	5	0, 100, 0	1.0	0.18	0.00
July 26, 1999	2	0, 100, 0	1.0	0.52	0.44
	3	0, 100, 0	0.9	0.54	0.50
	4	0, 100, 0	1.1	0.57	0.48
	5	0, 100, 0	1.0	0.61	0.58
Oct 6, 1999	2	0, 100, 0	5.0	0.98	0.40
	3	0, 100, 0	4.5	1.06	0.30
	4	0, 100, 0	5.9	0.94	0.40
	5	0, 100, 0	6.0	0.91	0.49

Appendix A-37. Chemical habitat data collected over Fish 174 from May 8, 1999 to May 25, 1999.

Date	Time (hrs)	Water temp (°C)	Dissolved oxygen (mg/L)	Conductivity (µS)	Specific Conductivity (µS)	Total suspended solids (mg/L)
May 8, 1999	1130	12.1	10.45	315.1	421.2	708
May 20, 1999	1130	18.1	8.52	698.0	787.0	290
May 25, 1999	1215	19.8	8.00	562.0	624.0	998

Appendix A-38. Physical habitat data collected over Fish 174 from May 8, 1999 to May 25, 1999.

Date	Time (hrs)	GPS location	Substrate (%silt, %sand, %gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
May 8, 1999	1130	41 10.42N 96 19.13W	0, 100, 0	5.2	0.88	0.65
May 20, 1999	1130	41 07.23N 96 18.80W	0, 100, 0	2.7	0.58	0.34
May 25, 1999	1215	41 06.31N 96 19.46W	0, 100, 0	2.6	0.74	0.52

Appendix A-39. Physical habitat data collected surrounding Fish 174 from May 8, 1999 to May 25, 1999.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
May 8, 1999	2	0, 100, 0	3.9	0.82	0.98
	3	0, 100, 0	5.6	0.80	0.04
	4	0, 100, 0	4.4	0.95	0.70
	5	0, 100, 0	4.2	0.79	0.63
May 20 ,1999	2	0, 100, 0	2.9	0.47	0.29
	3	0, 100, 0	2.5	0.51	0.28
	4	0, 100, 0	2.5	0.52	0.39
	5	0, 100, 0	2.9	0.49	0.19
May 25, 1999	2	0, 100, 0	2.8	0.66	0.16
	3	0, 100, 0	2.5	0.77	0.01
	4	0, 100, 0	2.8	0.93	0.55
	5	0, 100, 0	3.2	0.73	0.16

Appendix A-40. Chemical habitat data collected over Fish 184 from July 26, 1999 to September 8, 1999.

Date	Time (hrs)	Water temp (°C)	Dissolved oxygen (mg/L)	Conductivity (µS)	Specific Conductivity (µS)	Total suspended solids (mg/L)
July 26, 1999	1015	28.8	6.59	557.0	519.0	184
Aug 5, 1999	0930	23.5	8.26	740.0	768.0	501
Aug 16, 1999	0845	23.7	6.87	619.0	635.0	414
Aug 27, 1999	1245	27.2	10.23	976.0	936.0	182
Sept 8, 1999	1100	22.3	10.35	665.0	703.0	182

Appendix A-41. Physical habitat data collected over Fish 184 from June 26, 1999 to September 8, 1999.

Date	Time (hrs)	GPS location	Substrate (%silt, %sand, %gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
June 26, 1999	1015	41 06.54N 96 19.01W	0, 100, 0	5.4	0.96	0.70
Aug 5, 1999	0930	41 01.93N 96 08.03W	0, 100, 0	6.2	0.79	0.42
Aug 16, 1999	0845	41 00.58N 96 09.89W	0, 100, 0	2.5	0.73	0.54
Aug 27, 1999	1245	41 00.03N 96 11.65W	0, 100, 0	5.1	0.74	0.56
Sept 8, 1999	1100	40 59.90N 96 13.87W	0, 100, 0	3.9	0.82	0.43

Appendix A-42. Physical habitat data collected surrounding Fish 184 from July 26, 1999 to Sept 8, 1999.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
July 26, 1999	2	0, 100, 0	5.8	1.08	0.41
	3	0, 100, 0	5.5	1.00	0.34
	4	0, 100, 0	6.0	0.95	0.59
	5	0, 100, 0	5.5	0.93	0.72
Aug 5, 1999	2	0, 100, 0	6.5	0.89	0.60
	3	0, 100, 0	5.6	0.66	0.51
	4	0, 100, 0	5.4	0.39	0.37
	5	0, 100, 0	6.5	0.68	0.16
Aug 16, 1999	2	0, 100, 0	2.0	0.98	0.83
	3	0, 100, 0	3.3	0.94	0.10
	4	0, 100, 0	2.2	0.96	0.88
	5	0, 100, 0	2.0	0.90	0.74
Aug 27, 1999	2	0, 100, 0	5.3	0.67	0.41
	3	0, 100, 0	5.5	0.65	0.47
	4	0, 100, 0	5.9	0.56	0.36
	5	0, 100, 0	5.4	0.69	0.43
Sept 8, 1999	2	0, 100, 0	3.8	1.06	0.10
	3	0, 100, 0	4.3	0.90	0.11
	4	0, 100, 0	3.9	1.05	0.20
	5	0, 100, 0	3.9	1.00	0.09

Appendix A-43. Chemical habitat data collected over Fish 195 on May 26, 1999.

Date	Time (hrs)	Water temp (°C)	Dissolved oxygen (mg/L)	Conductivity (µS)	Specific Conductivity (µS)	Total suspended solids (mg/L)
May 26, 1999	1130	20.1	7.69	686.0	757.0	504

Appendix A-44. Physical habitat data collected over Fish 195 on May 26, 1999.

Date	Time (hrs)	GPS location	Substrate (%silt, %sand, %gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
May 26, 1999	1130	41 00.03N 96 11.57W	0, 100, 0	4.0	0.43	0.17

Appendix A-45. Physical habitat data collected surrounding Fish 195 on May 26, 1999.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
May 26, 1999	2	0, 100, 0	5.5	0.49	0.39
	3	0, 100, 0	4.5	0.49	0.21
	4	0, 100, 0	1.8	0.50	0.08
	5	0, 100, 0	3.2	0.37	0.06

Appendix A-46. Chemical habitat data collected over Fish 341 from May 20, 1998 to September 3, 1998.

Date	Time (hrs)	Water temp (°C)	Dissolved oxygen (mg/L)	Conductivity (µS)	Specific Conductivity (µS)	Total suspended solids (mg/L)
May 20, 1998	1230	24.8	7.28	507.0	508.0	343
June 2, 1998	1145	22.8	12.55	497.0	519.0	196
July 2, 1998	1430	29.5	11.18	506.0	463.0	196
July 6, 1998	1245	29.3	7.93	645.0	321.0	400
July 15, 1998	1100	26.7	9.70	470.0	460.0	164
July 17, 1998	1030	27.9	8.32	498.0	472.0	136
July 22, 1998	1200	26.8	8.42	532.0	515.0	132
July 28, 1998	1200	28.0	10.38	445.0	421.0	104
July 29, 1998	1140	27.0	9.02	437.0	421.0	188
Aug 5, 1998	1030	23.2	8.21	460.0	476.0	296
Aug 12, 1998	1215	26.6	9.55	543.0	527.0	168
Aug 13, 1998	1215	26.7	8.95	541.0	524.0	212
Aug 18, 1998	1200	29.5	8.18	537.0	495.0	160
Aug 27, 1998	1230	24.5	8.68	389.0	393.0	156
Sept 3, 1998	1145	24.6	9.29	528.0	533.0	116

Appendix A-47. Physical habitat data collected over Fish 341 from May 20, 1998 to September 3, 1998.

Date	Time (hrs)	GPS location	Substrate (%silt, %sand, %gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
May 20, 1998	1230	NA	0, 95, 5	2.1	0.84	0.45
June 2, 1998	1145	NA	0, 100, 0	2.8	0.94	0.21
July 2, 1998	1430	NA	0, 90, 10	3.9	0.97	0.05
July 6, 1998	1245	NA	0, 100, 0	2.3	0.72	0.43
July 15, 1998	1100	41 12.42N 96 20.93W	0, 95, 5	2.9	0.72	0.02
July 17, 1998	1030	41 12.41N 96 20.95W	0, 100, 0	2.0	0.70	0.51
July 22, 1998	1200	41 12.41N 96 20.95W	0, 100, 0	2.4	0.90	0.06
July 28, 1998	1200	41 12.37N 96 20.92W	0, 100, 0	1.8	0.43	0.34
July 29, 1998	1140	41 12.41N 96 20.93W	0, 100, 0	2.1	0.60	0.48
Aug 5, 1998	1030	41 12.37N 96 20.90W	0, 100, 0	2.0	0.41	0.13
Aug 12, 1998	1215	41 12.33N 96 20.91W	0, 100, 0	1.1	0.32	0.21
Aug 13, 1998	1215	41 12.36N 96 20.88W	0, 100, 0	1.7	0.60	0.46
Aug 18, 1998	1200	41 12.37N 96 20.90W	0, 100, 0	1.0	0.52	0.41
Aug 27, 1998	1230	41 12.32N 96 20.83W	0, 100, 0	0.9	0.22	0.13
Sept 3, 1998	1145	41 12.37N 96 20.90W	0, 100, 0	0.8	0.20	0.00

Appendix A-48. Physical habitat data collected surrounding Fish 341 from May 20, 1998 to September 3, 1998.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
May 20, 1998	2	0, 100, 0	1.4	0.31	0.20
	3	0, 95, 5	2.0	0.72	0.40
	4	0, 95, 5	1.6	0.55	0.39
	5	0, 95, 5	1.9	0.75	0.02
June 2, 1998	2	0, 100, 0	4.8	1.10	0.49
	3	0, 100, 0	2.6	0.85	0.61
	4	0, 100, 0	2.8	0.24	-0.21
	5	0, 100, 0	2.5	1.08	0.08
July 2, 1998	2	0, 100, 0	4.8	0.73	0.41
	3	0, 100, 0	3.2	1.10	0.63
	4	0, 100, 0	2.7	1.03	0.79
	5	0, 90, 10	3.4	0.90	0.69
July 6, 1998	2	0, 100, 0	2.7	0.75	0.48
	3	0, 100, 0	2.4	0.91	0.19
	4	0, 100, 0	1.9	0.88	0.76
	5	0, 100, 0	2.2	0.81	0.49
July 15, 1998	2	0, 100, 0	2.6	0.89	0.31
	3	0, 100, 0	2.9	0.70	0.60
	4	0, 100, 0	2.7	0.65	0.41
	5	0, 100, 0	2.3	0.84	0.65
July 17, 1998	2	0, 100, 0	2.6	0.60	0.35
	3	0, 100, 0	2.1	0.68	0.35
	4	0, 100, 0	2.2	0.80	0.51
	5	0, 100, 0	1.9	0.74	0.50

Appendix A-48. Continued.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
July 22, 1998	2	0, 100, 0	3.3	0.81	0.55
	3	0, 100, 0	2.4	0.89	0.58
	4	0, 100, 0	2.8	0.74	0.42
	5	0, 100, 0	2.9	0.89	0.04
July 28, 1998	2	0, 100, 0	1.8	0.51	0.46
	3	0, 100, 0	1.9	0.55	0.19
	4	0, 100, 0	1.3	0.42	0.36
	5	0, 100, 0	1.8	0.43	0.33
July 29, 1998	2	0, 100, 0	1.7	0.69	0.61
	3	0, 100, 0	2.0	0.61	0.31
	4	0, 100, 0	1.9	0.62	0.46
	5	0, 100, 0	1.9	0.65	0.59
Aug 5, 1998	2	0, 100, 0	1.7	0.49	0.13
	3	0, 100, 0	1.8	0.56	0.01
	4	0, 100, 0	1.5	0.59	0.48
	5	0, 100, 0	1.2	0.63	0.58
Aug 12, 1998	2	0, 100, 0	1.3	0.29	0.21
	3	0, 100, 0	1.2	0.28	0.21
	4	0, 100, 0	0.9	0.31	0.27
	5	0, 100, 0	1.0	0.36	0.04
Aug 13, 1998	2	0, 80, 20	2.2	0.57	-0.10
	3	0, 100, 0	1.7	0.62	0.51
	4	0, 100, 0	1.8	0.69	0.14
	5	0, 100, 0	1.6	0.51	0.30

Appendix A-48. Continued.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
Aug 18, 1998	2	0, 100, 0	0.9	0.47	0.41
	3	0, 100, 0	1.2	0.56	0.32
	4	0, 100, 0	1.0	0.56	0.50
	5	0, 100, 0	1.1	0.48	0.42
Aug 27, 1998	2	0, 100, 0	0.8	0.11	0.09
	3	0, 100, 0	0.9	0.30	0.21
	4	0, 100, 0	0.9	0.30	0.22
	5	0, 100, 0	0.9	0.23	0.06
Sept 3, 1998	2	0, 100, 0	0.8	0.53	0.44
	3	0, 100, 0	0.7	0.43	0.37
	4	0, 100, 0	0.5	0.48	0.41
	5	0, 100, 0	0.8	0.49	0.36

Appendix A-49. Chemical habitat data collected over Fish 361 from May 20, 1998 to June 22, 1998.

Date	Time (hrs)	Water temp (°C)	Dissolved oxygen (mg/L)	Conductivity (µS)	Specific Conductivity (µS)	Total suspended solids (mg/L)
May 20, 1998	1230	26.3	8.35	568.0	555.0	444
June 2, 1998	1220	23.7	12.40	510.0	523.0	192

Appendix A-50. Physical habitat data collected over Fish 361 from May 20, 1998 to June 2, 1998.

Date	Time (hrs)	GPS location	Substrate (%silt, %sand, %gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
May 20, 1998	1230	NA	0, 100, 0	2.8	0.69	0.49
June 2, 1998	1220	NA	0, 100, 0	2.0	0.54	-0.05

Appendix A-51. Physical habitat data collected surrounding Fish 361 from May 20, 1998 to June 2, 1998.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
May 20, 1998	2	0, 100, 0	2.5	0.68	0.54
	3	0, 100, 0	2.4	0.58	0.50
	4	0, 100, 0	2.5	0.61	0.31
	5	0, 100, 0	2.6	0.64	0.41
June 2, 1998	2	0, 100, 0	1.0	0.78	0.59
	3	0, 100, 0	1.2	0.71	0.64
	4	0, 100, 0	1.1	0.61	0.56
	5	0, 100, 0	1.5	0.73	0.03

Appendix A-52. Chemical habitat data collected over Fish 381 from May 20, 1998 to August 12, 1998.

Date	Time (hrs)	Water temp (°C)	Dissolved oxygen (mg/L)	Conductivity (µS)	Specific Conductivity (µS)	Total suspended solids (mg/L)
May 20, 1998	1300	25.8	8.90	526.0	518.0	272
May 26, 1998	1330	20.1	9.74	481.0	530.0	260
June 4, 1998	1330	14.9	10.58	422.1	523.0	108
July 2, 1998	1500	29.7	11.10	510.0	569.0	172
July 6, 1998	1330	29.5	8.05	344.0	185.0	356
July 15, 1998	1145	27.2	9.93	487.0	467.0	172
July 17, 1998	1100	28.8	8.56	504.0	473.0	152
July 22, 1998	1215	26.6	8.05	557.0	544.0	208
July 28, 1998	1210	28.9	10.13	442.0	415.0	172
July 29, 1998	1200	27.0	9.10	438.0	422.0	172
July 31, 1998	1300	24.8	11.03	430.0	433.0	240
Aug 5, 1998	1045	23.5	8.67	458.0	472.0	300
Aug 12, 1998	1245	26.6	9.79	552.0	537.0	180

Appendix A-53. Physical habitat data collected over Fish 381 from May 20, 1998 to August 12, 1998.

Date	Time (hrs)	GPS location	Substrate (%silt, %sand, %gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
May 20, 1998	1300	NA	0, 100, 0	2.3	0.63	0.52
May 26, 1998	1330	NA	0, 100, 0	4.0	1.26	0.92
June 4, 1998	1330	NA	0, 100, 0	2.1	0.45	0.43
July 2, 1998	1500	NA	0, 100, 0	3.5	0.94	0.12
July 6, 1998	1330	NA	0, 100, 0	2.1	0.89	0.67
July 15, 1998	1145	41 12.88N 96 21.26W	0, 100, 0	2.9	0.66	0.38
July 17, 1998	1100	41 12.78N 96 21.21W	0, 100, 0	3.4	0.80	0.32
July 22, 1998	1215	41 12.86N 96 21.23W	0, 100, 0	1.5	0.87	0.56
July 28, 1998	1210	41 12.82N 96 21.22W	0, 100, 0	4.5	0.78	0.06
July 29, 1998	1200	41 12.83N 96 21.22W	0, 100, 0	4.4	0.88	0.37
July 31, 1998	1300	41 12.86N 96 21.20W	0, 100, 0	4.6	1.14	0.68
Aug 5, 1998	1045	41 12.84N 96 21.22W	0, 100, 0	3.3	0.62	0.50
Aug 12, 1998	1245	41 12.85N 96 21.25W	0, 100, 0	2.2	0.29	0.23

Appendix A-54. Physical habitat data collected surrounding Fish 381 from May 20, 1998 to August 12, 1998.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
May 20, 1998	2	0, 100, 0	1.8	0.91	0.86
	3	0, 100, 0	2.1	0.92	0.34
	4	0, 100, 0	2.3	0.87	0.32
	5	0, 95, 5	2.5	0.73	0.11
May 26, 1998	2	0, 100, 0	4.4	0.69	0.34
	3	0, 100, 0	5.1	1.23	-0.23
	4	0, 100, 0	5.1	1.05	0.12
	5	0, 100, 0	4.5	1.23	0.26
June 4, 1998	2	0, 100, 0	2.4	0.57	0.22
	3	0, 100, 0	2.0	0.54	0.45
	4	0, 100, 0	2.3	0.26	0.10
	5	0, 100, 0	2.3	0.40	0.38
July 2, 1998	2	0, 100, 0	3.8	0.94	0.71
	3	0, 100, 0	3.6	1.07	0.03
	4	0, 100, 0	3.6	1.02	0.65
	5	0, 100, 0	3.9	0.96	0.53
July 6, 1998	2	0, 100, 0	2.2	0.68	0.65
	3	0, 100, 0	2.4	0.83	0.25
	4	0, 100, 0	1.7	0.90	0.59
	5	0, 100, 0	2.8	0.73	0.03
July 15, 1998	2	0, 100, 0	3.0	0.95	0.14
	3	0, 100, 0	2.3	0.68	0.62
	4	0, 100, 0	1.8	0.44	0.04
	5	0, 100, 0	3.0	0.60	0.47

Appendix A-54. Continued.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
July 17, 1998	2	0, 100, 0	3.4	0.92	0.36
	3	0, 100, 0	2.5	0.84	0.22
	4	0, 100, 0	2.7	1.05	0.46
	5	0, 100, 0	3.0	1.12	0.00
July 22, 1998	2	0, 100, 0	2.0	0.80	0.61
	3	0, 100, 0	1.5	0.80	0.73
	4	0, 100, 0	1.7	0.71	0.54
	5	0, 100, 0	1.7	0.62	0.43
July 28, 1999	2	0, 100, 0	4.8	0.83	0.45
	3	0, 100, 0	4.7	0.69	0.29
	4	0, 100, 0	4.8	0.81	0.32
	5	0, 100, 0	4.5	0.81	0.42
July 29, 1999	2	0, 100, 0	5.3	0.85	0.28
	3	0, 100, 0	3.7	1.04	0.64
	4	0, 100, 0	3.2	0.98	0.54
	5	0, 100, 0	3.9	1.02	0.45
July 31, 1998	2	0, 100, 0	4.8	1.27	0.20
	3	0, 100, 0	4.6	1.05	0.04
	4	0, 100, 0	5.3	0.96	0.24
	5	0, 100, 0	5.1	1.00	0.36
Aug 5, 1998	2	0, 100, 0	3.8	0.64	0.37
	3	0, 100, 0	3.1	0.59	0.36
	4	0, 100, 0	3.4	0.56	0.36
	5	0, 100, 0	3.0	0.55	0.31

Appendix A-54. Continued.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
Aug 12, 1998	2	0, 100, 0	2.3	0.39	0.35
	3	0, 100, 0	2.3	0.39	0.30
	4	0, 100, 0	2.1	0.35	0.27
	5	0, 100, 0	2.0	0.29	0.39

Appendix A-55. Chemical habitat data collected over Fish 401 from June 4, 1998 to October 8, 1998.

Date	Time (hrs)	Water temp (°C)	Dissolved oxygen (mg/L)	Conductivity (µS)	Specific Conductivity (µS)	Total suspended solids (mg/L)
June 4, 1998	1230	14.8	10.35	418.3	520.0	132
June 9, 1998	1230	15.9	8.63	386.0	453.0	500
July 2, 1998	1400	29.3	10.94	509.0	470.0	200
July 8, 1998	1200	28.8	7.63	438.0	408.0	368
July 13, 1998	1200	28.9	9.26	476.0	444.0	264
July 16, 1998	1600	33.7	8.82	549.0	477.0	152
July 22, 1998	1045	25.5	6.12	455.0	470.0	672
July 28, 1998	1045	26.8	9.51	450.0	435.0	248
July 29, 1998	1100	27.0	8.49	456.0	440.0	248
Aug 4, 1998	1130	25.5	8.59	522.0	517.0	336
Aug 12, 1998	1100	26.4	9.44	544.0	531.0	220
Aug 13, 1998	1115	26.0	8.71	514.0	480.0	256
Aug 18, 1998	1045	28.7	8.12	542.0	506.0	196
Aug 27, 1998	1100	23.4	8.78	385.0	397.0	200
Sept 3, 1998	1100	23.9	9.32	512.0	520.0	176
Sept 10, 1998	1140	20.3	11.86	505.0	554.0	204
Sept 17, 1998	1030	22.5	8.04	477.0	500.0	220
Sept 24, 1998	1100	17.7	11.62	386.0	449.0	188
Oct 1, 1998	1230	17.6	9.70	370.0	432.0	232
Oct 8, 1998	1115	13.6	11.05	342.0	438.0	224

Appendix A-56. Physical habitat data collected over Fish 401 from June 4, 1998 to October 8, 1998.

Date	Time (hrs)	GPS location	Substrate (%silt, %sand, %gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
June 4, 1998	1230	NA	0, 100, 0	3.3	0.98	0.30
June 9, 1998	1230	NA	0, 100, 0	2.8	1.07	0.87
July 2, 1998	1400	NA	0, 100, 0	1.2	0.60	0.55
July 8, 1998	1200	NA	0, 100, 0	2.6	0.89	0.42
July 13, 1998	1200	41 11.15N 96 19.35W	0, 100, 0	2.1	0.86	0.44
July 16, 1998	1600	41 11.12N 96 19.33W	0, 100, 0	3.1	0.68	0.55
July 22, 1998	1045	41 11.12N 96 19.34W	0, 100, 0	2.5	0.48	0.36
July 28, 1998	1045	41 11.11N 96 19.33W	0, 100, 0	2.7	0.48	0.35
July 29, 1998	1100	41 11.11N 96 19.31W	0, 100, 0	2.3	0.60	-0.01
Aug 4, 1998	1130	41 11.01N 96 19.29W	0, 100, 0	1.9	0.87	0.70
Aug 12, 1998	1100	41 11.08N 96 19.31W	0, 100, 0	1.4	0.33	0.25
Aug 13, 1998	1115	41 11.06N 96 19.30W	0, 100, 0	1.7	0.71	0.52
Aug 18, 1998	1045	41 11.04N 96 19.36W	0, 90, 10	1.9	0.40	0.16
Aug 27, 1998	1100	41 10.99N 96 19.32W	0, 100, 0	2.2	0.56	0.35
Sept 3, 1998	1100	41 11.00N 96 19.28W	0, 100, 0	1.5	0.13	0.07
Sept 10, 1998	1140	41 10.98N 96 19.29W	0, 100, 0	1.4	0.25	0.33
Sept 17, 1998	1030	41 10.97N 96 19.31W	0, 100, 0	1.4	0.54	0.24
Sept 24, 1998	1100	41 10.99N 96 19.32W	0, 100, 0	1.4	0.23	0.20
Oct 1, 1998	1230	41 10.97N 96 19.31W	0, 100, 0	1.5	0.43	0.16
Oct 8, 1998	1115	41 10.97N 96 19.27W	0, 100, 0	1.5	0.36	0.13

Appendix A-57. Physical habitat data collected surrounding Fish 401 from June 4, 1998 to October 8, 1998.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
June 4, 1998	2	0, 100, 0	1.9	0.71	0.59
	3	20, 80, 0	2.9	1.03	0.67
	4	0, 100, 0	4.5	0.85	0.47
	5	0, 100, 0	3.3	0.67	0.59
June 9, 1998	2	0, 100, 0	3.1	1.05	0.68
	3	0, 100, 0	3.0	1.12	0.63
	4	0, 100, 0	3.4	0.97	0.58
	5	0, 100, 0	3.1	0.93	0.63
July 2, 1998	2	0, 100, 0	1.3	0.78	0.68
	3	0, 100, 0	1.7	0.65	0.60
	4	0, 100, 0	1.7	0.65	0.27
	5	0, 100, 0	1.4	0.75	0.00
July 8, 1998	2	0, 100, 0	3.4	0.81	0.52
	3	0, 100, 0	2.2	1.04	0.76
	4	0, 100, 0	2.8	0.75	0.40
	5	0, 100, 0	2.4	0.83	0.47
July 13, 1998	2	0, 100, 0	2.8	0.54	0.03
	3	0, 100, 0	3.4	0.61	0.08
	4	0, 100, 0	1.5	0.70	0.63
	5	0, 100, 0	1.7	0.68	0.51
July 16, 1998	2	0, 100, 0	3.4	0.73	0.52
	3	0, 100, 0	2.9	0.75	0.44
	4	0, 100, 0	1.8	0.38	0.23
	5	0, 100, 0	2.9	0.72	0.56

Appendix A-57. Continued.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
July 22, 1998	2	0, 100, 0	3.0	0.61	0.46
	3	0, 100, 0	2.9	0.56	0.28
	4	0, 100, 0	0.8	0.43	0.24
	5	0, 100, 0	2.8	0.52	0.28
July 28, 1998	2	0, 100, 0	2.3	0.90	0.64
	3	0, 100, 0	3.4	0.83	0.59
	4	0, 100, 0	2.7	0.68	0.35
	5	0, 100, 0	2.2	0.73	0.52
July 29, 1998	2	0, 100, 0	2.7	0.54	0.12
	3	0, 100, 0	2.1	0.64	0.58
	4	0, 100, 0	1.9	0.87	0.78
	5	0, 100, 0	2.1	0.66	0.54
Aug 4, 1998	2	0, 100, 0	2.3	0.73	0.55
	3	0, 100, 0	2.3	0.64	0.49
	4	0, 100, 0	2.2	0.72	0.46
	5	0, 100, 0	2.0	0.76	0.66
Aug 12, 1998	2	0, 100, 0	1.9	0.44	0.22
	3	0, 100, 0	1.3	0.37	0.33
	4	0, 100, 0	1.3	0.26	0.19
	5	0, 100, 0	1.5	0.15	0.07
Aug 13, 1998	2	0, 100, 0	1.0	0.60	0.46
	3	0, 100, 0	1.6	0.70	0.57
	4	0, 100, 0	1.8	0.50	0.54
	5	0, 100, 0	1.8	0.65	0.35

Appendix A-57. Continued.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
Aug 18, 1998	2	0, 100, 0	2.1	0.48	0.45
	3	40, 60, 0	1.7	0.40	0.35
	4	10, 90, 0	2.0	0.15	0.13
	5	0, 100, 0	1.2	0.59	0.51
Aug 27, 1998	2	0, 100, 0	2.2	0.34	0.25
	3	0, 100, 0	3.5	0.57	0.07
	4	0, 100, 0	4.0	0.51	0.47
	5	0, 100, 0	2.5	0.36	0.23
Sept 3, 1998	2	0, 100, 0	1.5	0.20	0.07
	3	0, 100, 0	1.6	0.21	0.10
	4	0, 100, 0	1.5	0.21	0.14
	5	0, 100, 0	1.5	0.20	0.02
Sept 10, 1998	2	0, 100, 0	1.4	0.32	0.28
	3	0, 100, 0	1.3	0.37	0.22
	4	0, 100, 0	1.1	0.31	0.26
	5	0, 100, 0	1.4	0.10	-0.16
Sept 17, 1998	2	0, 100, 0	1.2	0.59	0.33
	3	0, 100, 0	1.4	0.56	0.45
	4	0, 100, 0	1.3	0.38	0.15
	5	0, 100, 0	2.2	0.13	-0.13
Sept 24, 1998	2	0, 100, 0	1.5	0.16	0.16
	3	0, 100, 0	1.5	0.19	0.12
	4	0, 100, 0	1.2	0.17	0.03
	5	0, 100, 0	1.0	0.46	0.10

Appendix A-57. Continued.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
Oct 1, 1998	2	0, 100, 0	1.9	0.65	0.45
	3	0, 100, 0	1.2	0.43	0.41
	4	0, 100, 0	1.0	0.13	0.02
	5	0, 100, 0	1.0	0.48	0.06
Oct 8, 1998	2	0, 100, 0	1.6	0.06	0.06
	3	0, 100, 0	1.6	0.25	0.14
	4	0, 100, 0	1.4	0.25	0.11
	5	0, 100, 0	0.7	0.23	0.22

Appendix A-58. Chemical habitat data collected over Fish 441 from June 4, 1998 to September 3, 1998.

Date	Time (hrs)	Water temp (°C)	Dissolved oxygen (mg/L)	Conductivity (µS)	Specific Conductivity (µS)	Total suspended solids (mg/L)
June 4, 1998	1100	14.5	9.93	432.7	544.0	132
June 5, 1998	1100	13.1	10.77	493.0	581.0	136
June 9, 1998	1130	15.6	8.78	427.7	521.0	584
July 2, 1998	1300	28.4	10.73	515.0	483.0	216
July 8, 1998	1130	28.8	7.44	475.0	445.0	380
July 13, 1998	1100	28.1	8.59	494.0	467.0	212
July 16, 1998	1600	33.2	9.05	550.0	484.0	NA
July 22, 1998	1015	25.2	7.20	502.0	500.0	124
July 28, 1998	1030	26.6	9.30	452.0	437.0	256
July 29, 1998	1030	26.8	7.85	486.0	469.0	264
Aug 4, 1998	1100	25.2	8.06	528.0	550.0	356
Aug 12, 1998	1045	26.2	9.42	562.0	549.0	220
Aug 13, 1998	1100	26.0	8.13	586.0	575.0	268
Aug 18, 1998	1030	28.3	NA	550.0	517.0	196
Aug 27, 1998	1045	23.2	8.85	382.0	390.0	168
Sept 3, 1998	1030	23.7	9.05	501.0	514.0	164

Appendix A-59. Physical habitat data collected over Fish 441 from June 4, 1998 to September 3, 1998.

Date	Time (hrs)	GPS location	Substrate (%silt, %sand, %gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
June 4, 1998	1100	NA	0, 100, 0	3.9	1.02	0.61
June 5, 1998	1100	NA	0, 100, 0	3.0	1.06	0.78
June 9, 1998	1130	NA	0, 100, 0	5.5	0.92	0.60
July 2, 1998	1300	NA	0, 100, 0	1.4	0.86	0.64
July 8, 1998	1130	NA	0, 100, 0	1.5	0.63	0.23
July 13, 1998	1100	41 10.26N 96 19.17W	0, 100, 0	2.3	0.67	0.07
July 16, 1998	1600	41 10.20N 96 19.18W	0, 100, 0	2.4	0.96	0.69
July 22, 1998	1015	41 10.24N 96 19.18W	0, 100, 0	1.8	0.64	0.26
July 28, 1998	1030	41 10.24N 96 19.15W	0, 100, 0	3.1	0.94	0.01
July 29, 1998	1030	41 10.23N 96 19.19W	0, 100, 0	3.2	0.54	0.14
Aug 4, 1998	1100	41 10.19N 96 19.16W	0, 100, 0	2.6	1.03	0.83
Aug 12, 1998	1045	41 10.23N 96 19.17W	0, 100, 0	2.4	0.76	0.61
Aug 13, 1998	1100	41 10.20N 96 19.18W	0, 100, 0	1.7	0.53	-0.03
Aug 18, 1998	1030	41 10.20N 96 19.16W	0, 100, 0	1.5	0.62	0.56
Aug 27, 1998	1045	41 10.23N 96 19.17W	0, 100, 0	3.7	0.82	0.45
Sept 3, 1998	1030	41 10.24N 96 19.16W	0, 100, 0	3.6	0.40	0.26

Appendix A-60. Physical habitat data collected surrounding Fish 441 from June 4, 1998 to September 3, 1998.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
June 4, 1998	2	0, 100, 0	4.6	0.97	-0.28
	3	0, 100, 0	3.5	0.98	0.43
	4	0, 100, 0	5.4	0.97	0.46
	5	0, 100, 0	4.8	0.83	0.25
June 5, 1998	2	0, 100, 0	3.6	1.08	0.58
	3	0, 100, 0	3.0	1.02	0.63
	4	0, 100, 0	3.5	0.98	0.46
	5	0, 100, 0	3.0	1.01	0.79
June 9, 1998	2	0, 100, 0	5.4	0.89	-0.07
	3	0, 100, 0	5.8	0.97	0.36
	4	0, 100, 0	5.3	0.98	0.40
	5	0, 100, 0	5.8	0.90	0.59
July 2, 1998	2	0, 100, 0	2.1	0.63	0.40
	3	0, 100, 0	1.8	0.52	0.25
	4	0, 100, 0	1.9	0.83	0.47
	5	0, 100, 0	2.6	0.80	0.80
July 8, 1998	2	0, 100, 0	1.2	0.57	0.51
	3	0, 100, 0	1.3	0.58	0.53
	4	0, 100, 0	1.3	0.58	0.45
	5	0, 100, 0	1.2	0.53	0.48
July 13, 1998	2	0, 100, 0	2.0	0.66	0.60
	3	0, 100, 0	2.5	0.82	0.03
	4	0, 100, 0	2.6	0.71	0.16
	5	0, 100, 0	2.1	0.64	0.19

Appendix A-60. Continued.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
July 16, 1998	2	0, 100, 0	2.6	0.97	0.80
	3	0, 100, 0	2.7	0.88	0.00
	4	0, 100, 0	2.3	0.89	0.70
	5	0, 100, 0	2.5	0.76	0.50
July 22, 1998	2	0, 100, 0	1.7	0.80	0.65
	3	0, 100, 0	1.6	0.66	0.56
	4	0, 100, 0	1.8	0.62	0.31
	5	0, 100, 0	1.8	0.66	0.27
July 28, 1998	2	0, 100, 0	3.2	0.99	0.36
	3	0, 100, 0	3.2	0.98	0.54
	4	0, 100, 0	2.4	0.82	-0.07
	5	0, 100, 0	3.2	0.74	0.43
July 29, 1998	2	0, 100, 0	2.9	0.71	0.44
	3	0, 100, 0	3.3	0.63	-0.02
	4	0, 100, 0	3.0	0.58	0.36
	5	0, 100, 0	3.1	0.52	0.23
Aug 4, 1998	2	0, 100, 0	2.5	0.94	0.67
	3	0, 100, 0	2.8	0.92	0.00
	4	0, 100, 0	3.5	1.08	0.04
	5	0, 100, 0	2.6	0.81	0.64
Aug 12, 1998	2	0, 100, 0	2.7	0.59	0.59
	3	0, 100, 0	2.8	0.76	0.61
	4	0, 100, 0	2.4	0.66	0.56
	5	0, 100, 0	2.5	0.68	0.48

Appendix A-60. Continued.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
Aug 13, 1998	2	0, 100, 0	1.6	0.72	0.60
	3	0, 100, 0	1.7	0.72	0.22
	4	0, 100, 0	1.1	0.66	0.62
	5	0, 100, 0	1.2	0.64	0.55
Aug 18, 1998	2	0, 100, 0	1.7	0.50	0.34
	3	0, 100, 0	1.5	0.76	0.15
	4	0, 100, 0	1.7	0.58	-0.01
	5	0, 100, 0	1.4	0.43	0.35
Aug 27, 1998	2	0, 100, 0	3.0	0.80	0.53
	3	0, 100, 0	3.4	0.82	0.01
	4	0, 100, 0	4.1	0.71	0.13
	5	0, 100, 0	3.5	0.66	0.21
Sept 3, 1998	2	0, 100, 0	3.4	0.44	0.41
	3	0, 100, 0	3.7	0.39	0.31
	4	0, 100, 0	3.7	0.27	0.36
	5	0, 100, 0	3.3	0.38	0.01

Appendix A-61. Chemical habitat data collected over Fish 481 from May 18, 1998 to October 8, 1998.

Date	Time (hrs)	Water temp (°C)	Dissolved oxygen (mg/L)	Conductivity (µS)	Specific Conductivity (µS)	Total suspended solids (mg/L)
May 18, 1998	1400	25.6	12.50	549.0	542.0	215
June 2, 1998	1330	25.2	12.48	541.0	539.0	248
June 9. 1998	1300	16.3	8.85	411.0	493.2	484
June 29, 1998	1300	29.2	8.98	510.0	462.0	180
July 6, 1998	1200	29.0	8.31	386.0	360.0	332
July 15, 1998	1000	26.8	9.43	490.0	472.0	164
July 17, 1998	1000	28.2	7.70	517.0	484.0	220
July 22, 1998	1100	26.1	6.60	507.0	497.0	532
July 28, 1998	1110	28.0	10.20	450.0	427.0	324
July 29, 1998	1100	27.0	8.83	450.0	437.0	220
Aug 5, 1998	1000	23.2	8.25	480.0	525.0	368
Aug 12, 1998	1130	26.6	9.45	565.0	546.0	208
Aug 13, 1998	1130	26.4	8.74	567.0	552.0	232
Aug 18, 1998	1130	29.3	8.31	559.0	516.0	168
Aug 27, 1998	1145	23.9	9.05	393.0	402.0	164
Sept 3, 1998	1130	24.7	9.49	511.0	514.0	152
Sept 10, 1998	1215	21.3	11.65	510.0	548.0	188
Sept 17, 1998	1100	22.6	8.37	240.0	252.0	220
Sept 24, 1998	1100	17.8	11.80	421.0	488.0	160
Oct 1, 1998	1300	17.9	10.02	389.0	450.0	224
Oct 8, 1998	1215	14.0	11.30	375.0	475.0	192

Appendix A-62. Physical habitat data collected over Fish 481 from May 18, 1998 to October 8, 1998.

Date	Time (hrs)	GPS location	Substrate (%silt, %sand, %gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
May 18, 1998	1400	NA	0, 100, 0	2.3	0.39	0.25
June 2, 1998	1330	NA	0, 100, 0	2.0	0.77	0.63
June 9, 1998	1300	NA	0, 100, 0	2.9	1.01	0.72
June 29, 1998	1300	NA	0, 100, 0	2.7	0.50	0.48
July 6, 1998	1200	NA	0, 100, 0	1.7	0.75	0.69
July 15, 1998	1000	41 12.42N 96 21.09W	0, 50, 50	1.6	0.55	0.13
July 17, 1998	1000	41 12.40N 96 21.10W	0, 100, 0	1.5	0.28	0.15
July 22, 1998	1100	41 12.37N 96 21.14W	0, 100, 0	0.9	0.49	0.36
July 28, 1998	1110	41 12.37N 96 21.11W	0, 100, 0	1.4	0.39	0.22
July 29, 1998	1100	41 12.39N 96 21.11W	0, 100, 0	1.2	0.69	0.22
Aug 5, 1998	1000	41 12.37N 96 21.07W	0, 100, 0	1.2	0.58	0.32
Aug 12, 1998	1130	41 12.40N 96 21.11W	0, 100, 0	1.5	0.03	0.00
Aug 13, 1998	1130	41 12.39N 96 21.09W	0, 100, 0	2.0	0.53	0.35
Aug 18, 1998	1130	41 12.39N 96 21.13W	0, 100, 0	1.1	0.45	0.20
Aug 27, 1998	1145	41 12.36N 96 21.11W	0, 60, 40	0.5	0.45	0.43
Sept 3, 1998	1130	41 12.41N 96 21.12W	0, 100, 0	0.9	0.48	0.38
Sept 10, 1998	1215	41 12.39N 96 21.12W	0, 100, 0	1.3	0.53	0.01
Sept 17, 1998	1100	41 12.37N 96 20.11W	0, 100, 0	1.1	0.33	0.28
Sept 24, 1998	1100	41 12.39N 96 21.09W	0, 100, 0	1.3	0.29	0.24
Oct 1, 1998	1300	41 12.38N 96 21.09W	0, 100, 0	1.5	0.46	0.23
Oct 8, 1998	1215	41 12.33N 96 21.08W	0, 100, 0	3.7	0.64	0.23

Appendix A-63. Physical habitat data collected surrounding Fish 481 from May 18, 1998 to October 8, 1998.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
May 18, 1998	2	0, 100, 0	2.0	0.45	0.35
	3	0, 100, 0	2.1	0.55	0.39
	4	0, 100, 0	2.1	0.43	0.26
	5	0, 100, 0	1.6	0.22	0.15
June 2, 1998	2	0, 100, 0	1.9	0.66	0.55
	3	0, 100, 0	1.7	0.75	0.55
	4	0, 100, 0	1.9	0.81	0.63
	5	0, 100, 0	1.8	0.64	0.62
June 9, 1998	2	0, 100, 0	4.2	0.62	-0.15
	3	0, 100, 0	2.4	1.08	0.82
	4	0, 100, 0	4.3	0.91	0.54
	5	0, 100, 0	3.4	1.03	0.28
June 29, 1998	2	0, 100, 0	2.5	0.58	0.45
	3	0, 100, 0	2.9	0.52	0.06
	4	0, 100, 0	2.4	0.16	0.06
	5	0, 100, 0	2.7	0.60	0.42
July 6, 1998	2	0, 100, 0	1.9	0.20	0.13
	3	0, 100, 0	2.0	0.50	0.44
	4	0, 100, 0	1.1	0.65	0.63
	5	0, 100, 0	1.5	0.83	0.12
July 15, 1998	2	0, 100, 0	1.2	0.56	0.52
	3	0, 95, 5	1.2	0.65	0.55
	4	0, 100, 0	1.0	0.70	0.09
	5	0, 100, 0	1.3	0.56	0.50

Appendix A-63. Continued.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
July 17, 1998	2	0, 100, 0	1.1	0.42	0.33
	3	0, 100, 0	1.8	0.51	0.41
	4	0, 100, 0	1.9	0.46	0.25
	5	0, 100, 0	0.8	0.55	0.38
July 22, 1998	2	0, 100, 0	1.0	0.34	0.30
	3	0, 100, 0	0.9	0.55	0.49
	4	0, 100, 0	0.6	0.57	0.51
	5	0, 100, 0	0.7	0.65	0.54
July 28, 1998	2	0, 100, 0	1.1	0.51	0.51
	3	0, 100, 0	1.4	0.37	0.05
	4	0, 100, 0	1.4	0.40	0.35
	5	0, 100, 0	1.1	0.61	0.58
July 29, 1998	2	0, 100, 0	1.2	0.71	0.53
	3	0, 100, 0	1.3	0.55	0.47
	4	0, 100, 0	0.9	0.66	0.55
	5	0, 100, 0	1.1	0.61	0.51
Aug 5, 1998	2	0, 100, 0	1.5	0.62	0.44
	3	0, 100, 0	1.0	0.64	0.29
	4	0, 100, 0	1.0	0.55	0.44
	5	0, 100, 0	1.1	0.73	0.60
Aug 12, 1998	2	0, 100, 0	1.7	0.20	0.13
	3	0, 100, 0	1.7	0.30	0.17
	4	0, 100, 0	1.5	0.04	0.12
	5	0, 100, 0	0.9	0.00	-0.02

Appendix A-63. Continued.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
Aug 13, 1998	2	0, 100, 0	2.0	0.48	0.40
	3	0, 100, 0	2.0	0.54	0.41
	4	0, 100, 0	2.0	0.39	0.29
	5	0, 100, 0	2.0	0.45	0.24
Aug 18, 1998	2	0, 100, 0	0.7	0.48	0.41
	3	0, 100, 0	1.0	0.57	0.55
	4	0, 100, 0	1.4	0.45	0.17
	5	0, 100, 0	1.0	0.45	0.15
Aug 27, 1998	2	0, 60, 40	0.5	0.42	0.41
	3	0, 60, 40	0.6	0.46	0.42
	4	0, 60, 40	0.5	0.44	0.42
	5	0, 60, 40	0.5	0.41	0.38
Sept 3, 1998	2	0, 100, 0	0.9	0.58	0.52
	3	0, 100, 0	1.0	0.48	0.43
	4	0, 100, 0	0.8	0.42	0.39
	5	0, 100, 0	0.9	0.50	0.42
Sept 10, 1998	2	0, 100, 0	0.8	0.56	0.51
	3	0, 100, 0	0.9	0.48	0.46
	4	0, 100, 0	0.7	0.50	0.35
	5	0, 100, 0	1.0	0.62	0.12
Sept 17, 1998	2	0, 100, 0	1.3	0.45	0.33
	3	0, 100, 0	1.0	0.33	0.29
	4	0, 100, 0	0.9	0.41	0.33
	5	0, 100, 0	1.1	0.43	0.30

Appendix A-63. Continued.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
Sept 24, 1998	2	0, 100, 0	1.0	0.33	0.25
	3	0, 100, 0	1.0	0.36	0.29
	4	0, 100, 0	0.9	0.45	0.39
	5	0, 100, 0	1.0	0.45	0.35
Oct 1, 1998	2	0, 100, 0	1.1	0.44	0.35
	3	0, 100, 0	1.5	0.57	0.55
	4	0, 100, 0	2.0	0.46	0.25
	5	0, 100, 0	1.5	0.40	0.00
Oct 8, 1998	2	0, 100, 0	2.9	0.64	0.31
	3	0, 100, 0	3.0	0.69	0.56
	4	0, 100, 0	3.3	0.84	0.53
	5	0, 100, 0	3.0	0.80	0.60

Appendix A-64. Chemical habitat data collected over Fish 501 from May 26, 1998 to June 29, 1998.

Date	Time (hrs)	Water temp (°C)	Dissolved oxygen (mg/L)	Conductivity (µS)	Specific Conductivity (µS)	Total suspended solids (mg/L)
May 26, 1998	1200	19.1	9.90	498.0	554.0	232
June 2, 1998	1455	26.0	12.52	551.0	540.0	232
June 9, 1998	1100	15.6	8.83	429.5	524.0	500
June 29, 1998	1145	28.1	8.55	475.0	450.0	220

Appendix A-65. Physical habitat data collected over Fish 501 from May 26, 1998 to June 29, 1998.

Date	Time (hrs)	GPS location	Substrate (%silt, %sand, %gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
May 26, 1998	1200	NA	0, 100, 0	2.4	0.68	0.14
June 2, 1998	1455	NA	0, 100, 0	4.5	0.72	0.22
June 9, 1998	1100	NA	0, 100, 0	2.8	0.97	-0.02
June 29, 1998	1145	NA	0, 100, 0	2.3	0.90	0.68

Appendix A-66. Physical habitat data collected surrounding Fish 501 from May 26, 1998 to June 29, 1998.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
May 26, 1998	2	0, 100, 0	2.3	0.60	0.40
	3	0, 100, 0	1.7	0.82	0.74
	4	0, 100, 0	1.7	0.44	0.35
	5	0, 100, 0	2.0	0.73	0.60
June 2, 1998	2	0, 100, 0	4.4	0.74	0.38
	3	0, 100, 0	4.5	0.68	0.40
	4	0, 100, 0	4.2	0.49	0.39
	5	0, 100, 0	4.4	0.6	0.36
June 9, 1998	2	0, 100, 0	3.3	0.74	0.03
	3	0, 100, 0	2.8	0.62	0.29
	4	0, 100, 0	2.0	1.10	0.77
	5	0, 100, 0	2.1	1.13	0.71
June 29, 1998	2	0, 100, 0	1.9	0.60	0.52
	3	0, 100, 0	2.5	0.77	0.69
	4	0, 100, 0	2.4	0.77	0.69
	5	0, 100, 0	2.4	0.71	0.16

Appendix A-67. Chemical habitat data collected over Fish 521 from July 8, 1998 to July 13, 1998.

Date	Time (hrs)	Water temp (°C)	Dissolved oxygen (mg/L)	Conductivity (µS)	Specific Conductivity (µS)	Total suspended solids (mg/L)
July 8, 1998	1330	29.8	7.55	410.0	415.0	464
July 13, 1998	1130	28.4	9.10	473.0	444.0	192

Appendix A-68. Physical habitat data collected over Fish 521 from July 8, 1998 to July 13, 1998.

Date	Time (hrs)	GPS location	Substrate (%silt, %sand, %gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
July 8, 1998	1330	NA	0, 100, 0	2.7	0.77	0.62
July 13, 1998	1130	41 11.11N 96 19.30W	0, 100, 0	3.8	1.02	0.58

Appendix A-69. Physical habitat data collected surrounding Fish 521 from July 8, 1998 to July 13, 1998.

Date	Position	Substrate (% silt, % sand, % gravel)	Depth (ft)	Mean column velocity (m/s)	Bottom current velocity (m/s)
July 8, 1998	2	0, 100, 0	3.8	0.73	0.52
	3	0, 100, 0	3.0	0.77	0.26
	4	0, 100, 0	1.1	0.47	0.46
	5	0, 100, 0	2.5	0.69	0.47
July 13, 1998	2	0, 100, 0	4.1	0.95	0.67
	3	0, 100, 0	3.6	1.18	0.02
	4	0, 100, 0	3.8	0.99	0.66
	5	0, 100, 0	4.5	0.82	-0.06

Appendix B-1. Movements of Fish 014 from April 21, 1999 to April 28, 2000.

Date	Location (rkm)	Surface survey	Aerial survey
April 21, 1999	65.0	X	
August 6, 1999	38.1		X
August 20, 1999	43.0		X
August 30, 1999	43.0		X
September 13, 1999	40.8		X
September 27, 1999	54.5		X
October 5, 1999	60.3	X	
October 11, 1999	58.7		X
October 25, 1999	47.5		X
November 8, 1999	Not located		X
November 22, 1999	39.3		X
December 14, 1999	36.7		X
January 7, 2000	28.7		X
January 21, 2000	27.2		X
February 11, 2000	16.5		X
March 3, 2000	Not located		X
March 10, 2000	Not located		X
March 17, 2000	28.7		X
March 24, 2000	Not located		X
March 31, 2000	Not located		X
April 7, 2000	Not located		X
April 14, 2000	54.4		X
April 21, 2000	67.9		X
April 28, 2000	71.4		X
May 5, 2000	Not located		X
May 10, 2000	Not located		X

Appendix B-2. Movements of Fish 034 from April 21 to June 1, 1999.

Date	Location (rkm)	Surface survey	Aerial survey
April 21, 1999	65.0	X	
May 17, 1999	63.6	X	
May 18, 1999	72.4	X	
May 25, 1999	64.1	X	
June 1, 1999	57.7	X	
June 8, 1999	Not located	X	
August 6, 1999	Not located		X

Appendix B-3. Movements of Fish 055 from April 21 to November 22, 1999.

Date	Location (rkm)	Surface survey	Aerial survey
April 21, 1999	65.0	X	
April 28, 1999	62.2	X	
May 8, 1999	60.7	X	
May 12, 1999	60.7	X	
May 17, 1999	60.8	X	
May 18, 1999	60.8	X	
May 20, 1999	60.8	X	
May 25, 1999	59.6	X	
June 1, 1999	58.3	X	
June 8, 1999	51.3	X	
June 11, 1999	55.5	X	
June 14, 1999	57.8	X	
June 16, 1999	51.6	X	
June 23, 1999	51.0	X	
June 24, 1999	51.0	X	
August 6, 1999	54.9		X
August 20, 1999	54.9		X
August 20,1999	54.9		X
September 13, 1999	64.0		X
September 27, 1999	70.5		X
October 11, 1999	86.0		X
October 25, 1999	65.3		X
November 8, 1999	28.0		X
November 22, 1999	1.7		X
December 14, 1999	Not located		X

Appendix B-4. Movements of Fish 065 from April 21 to May 25, 1999.

Date	Location (rkm)	Surface survey	Aerial survey
April 21, 1999	65.0	X	
April 28, 1999	62.0	X	
May 20, 1999	51.6	X	
May 25, 1999	50.9	X	
May 26, 1999	Not located	X	
August 6, 1999	Not located		X

Appendix B-5. Movements of Fish 075 from April 21 to May 25, 1999.

Date	Location (rkm)	Surface survey	Aerial survey
April 21, 1999	65.0	X	
April 28, 1999	58.7	X	
May 5, 1999	52.1	X	
May 17, 1999	52.2	X	
May 20, 1999	52.1	X	
May 25, 1999	49.3	X	
May 26, 1999	Not located	X	
August 6, 1999	Not located		X

Appendix B-6. Movements of Fish 095 from April 21, 1999 to May 12, 2000.

Date	Location (rkm)	Surface survey	Aerial survey
April 21, 1999	65.0	X	
June 16, 1999	68.5	X	
July 22, 1999	11.5	X	
August 6, 1999	Not located		X
August 20, 1999	14.0		X
August 30, 1999	14.0		X
September 8, 1999	12.0	X	
September 13, 1999	12.0		X
September 27, 1999	5.4		X
October 11, 1999	4.2		X
October 25, 1999	Not located		X
November 8, 1999	Not located		X
November 22, 1999	Not located		X
December 14, 1999	Not located		X
January 7, 2000	Not located		X
January 21, 2000	Not located		X
February 11, 2000	Not located		X
March 3, 2000	Not located		X
March 10, 2000	Not located		X
March 17, 2000	Not located		X
March 24, 2000	Not located		X
March 31, 2000	26.0		X
April 7, 2000	28.8		X
April 14, 2000	28.8		X
April 21, 2000	14.0		X
April 28, 2000	2.0		X
May 5, 2000	Not located		X
May 10, 2000	0.1		X
May 11, 2000	1.0	X	
May 12, 2000	1.0	X	

Appendix B-7. Movements of Fish 105 from April 21 to May 25, 1999.

Date	Location (rkm)	Surface survey	Aerial survey
April 21, 1999	65.0	X	
May 8, 1999	64.5	X	
May 12, 1999	64.5	X	
May 17, 1999	64.0	X	
May 20, 1999	63.9	X	
May 25, 1999	61.2	X	
May 26, 1999	Not located	X	
August 6, 1999	Not located		X

Appendix B-8. Movements of Fish 115 from April 21, 1999 to April 21, 2000.

Date	Location (rkm)	Surface survey	Aerial survey
April 21, 1999	65.0	X	
July 19, 1999	9.3	X	
August 6, 1999	Not located		X
August 20, 1999	Not located		X
August 30, 1999	Not located		X
September 13, 1999	Not located		X
September 27, 1999	Not located		X
October 11, 1999	Not located		X
October 25, 1999	Not located		X
November 8, 1999	Not located		X
November 22, 1999	Not located		X
December 14, 1999	Not located		X
January 7, 2000	Not located		X
January 21, 2000	Not located		X
February 11, 2000	Not located		X
March 3, 2000	Not located		X
March 10, 2000	Not located		X
March 17, 2000	Not located		X
March 24, 2000	Not located		X
March 31, 2000	Not located		X
April 7, 2000	Not located		X
April 14, 2000	Not located		X
April 21, 2000	24.0		X
April 28, 2000	Not located		X

Appendix B-9. Movements of Fish 124 from April 21 to July 14, 1999.

Date	Location (rkm)	Surface survey	Aerial survey
April 21, 1999	65.0	X	
April 28, 1999	62.6	X	
May 8, 1999	63.6	X	
June 1, 1999	59.1	X	
June 23, 1999	41.0	X	
July 7, 1999	23.0	X	
July 13, 1999	29.0	X	
July 14, 1999	28.5	X	
July 19, 1999	Not located	X	
August 6, 1999	Not located		X

Appendix B-10. Movements of Fish 134 from April 21 to June 16, 1999.

Date	Location (rkm)	Surface survey	Aerial survey
April 21, 1999	65.0	X	
June 16, 1999	59.0	X	
June 23, 1999	Not located	X	
August 6, 1999	Not located		X

Appendix B-11. Movements of Fish 155 from April 21, 1999 to May 5, 2000.

Date	Location (rkm)	Surface survey	Aerial survey
April 21, 1999	65.0	X	
July 28, 1999	24.7	X	
August 6, 1999	32.9		X
August 20, 1999	Not located		X
August 30, 1999	52.3		X
September 13, 1999	52.3		X
September 27, 1999	57.7		X
October 1, 1999	51.2	X	
October 11, 1999	28.2		X
October 25, 1999	40.2		X
November 8, 1999	51.2		X
November 22, 1999	51.2		X
December 14, 1999	51.2		X
January 7, 2000	33.1		X
January 21, 2000	29.0		X
February 11, 2000	Not located		X
March 3, 2000	29.0		X
March 10, 2000	32.2		X
March 17, 2000	32.2		X
March 24, 2000	32.2		X
March 31, 2000	Not located		X
April 7, 2000	48.5		X
April 14, 2000	48.5		X
April 21, 2000	41.9		X
April 28, 2000	43.6		X
May 5, 2000	52.1		X
May 10, 2000	Not located		X

Appendix B-12. Movements of Fish 164 from April 21, 1999 to May 5, 2000.

Date	Location	Surface survey	Aerial survey
April 21, 1999	65.0	X	
June 14, 1999	64.3	X	
June 16, 1999	59.2	X	
July 23, 1999	48.5	X	
July 26, 1999	48.5	X	
August 6, 1999	Not located		X
August 20, 1999	46.4		X
August 30, 1999	46.4		X
September 13, 1999	45.6		X
September 27, 1999	52.2		X
October 5, 1999	47.3	X	
October 11, 1999	45.6		X
October 25, 1999	52.2		X
November 8, 1999	61.3		X
November 22, 1999	41.6		X
December 14, 1999	38.3		X
January 7, 2000	Not located		X
January 21, 2000	Not located		X
February 11, 2000	Not located		X
March 3, 2000	32.2		X
March 10, 2000	46.4		X
March 17, 2000	46.4		X
March 24, 2000	46.4		X
March 31, 2000	49.0		X
April 7, 2000	49.0		X
April 14, 2000	46.2		X
April 21, 2000	48.4		X
April 28, 2000	48.4		X
May 5, 2000	31.9		X
May 10, 2000	Not located		X

Appendix B-13. Movements of Fish 174 from April 21 to May 25, 1999.

Date	Location (rkm)	Surface survey	Aerial survey
April 21, 1999	65.0	X	
May 8, 1999	58.3	X	
May 20, 1999	52.5	X	
May 25, 1999	50.0	X	
May 26, 1999	Not located	X	
August 6, 1999	Not located		X

Appendix B-14. Movements of Fish 184 from April 21, 1999 to April 28, 2000.

Date	Location (rkm)	Surface survey	Aerial survey
April 21, 1999	65.0	X	
July 26, 1999	50.5	X	
August 5, 1999	19.5	X	
August 6, 1999	24.9		X
August 16, 1999	31.5	X	
August 27, 1999	35.8	X	
August 30, 1999	34.7		X
September 8, 1999	38.9	X	
September 13, 1999	39.4		X
September 27, 1999	39.4		X
October 11, 1999	39.4		X
October 25, 1999	11.6		X
November 8, 1999	11.6		X
November 22, 1999	Not located		X
December 14, 1999	Not located		X
January 7, 2000	Not located		X
January 21, 2000	Not located		X
February 11, 2000	Not located		X
March 3, 2000	Not located		X
March 10, 2000	Not located		X
March 17, 2000	Not located		X
March 24, 2000	Not located		X
March 31, 2000	24.0		X
April 7, 2000	Not located		X
April 14, 2000	32.0		X
April 21, 2000	39.7		X
April 28, 2000	35.0		X
May 5, 2000	Not located		X

Appendix B-15. Movements of Fish 195 from April 21 to May 26, 1999.

Date	Location (rkm)	Surface survey	Aerial survey
April 21, 1999	65.0	X	
May 26, 1999	30.5	X	
May 30, 1999	Fish was harvested by angler. Transmitter was returned.		

Appendix B-16. Movements of Fish 341 from April 16 to September 3, 1998.

Date	Location (rkm)	Surface survey	Aerial survey
April 16, 1998	65.0	X	
April 17, 1998	63.6	X	
April 18, 1998	62.9	X	
April 21, 1998	63.7	X	
April 22, 1998	63.7	X	
April 24, 1998	63.7	X	
April 25, 1998	63.7	X	
April 28, 1998	63.7	X	
April 30, 1998	63.8	X	
May 1, 1998	63.8	X	
May 2, 1998	63.5	X	
May 3, 1998	63.5	X	
May 4, 1998	63.4	X	
May 5, 1998	63.2	X	
May 6, 1998	63.2	X	
May 7, 1998	63.2	X	
May 8, 1998	63.0	X	
May 13, 1998	63.0	X	
May 14, 1998	62.9	X	
May 20, 1998	62.6	X	
June 2, 1998	62.5	X	
June 17, 1998	62.8	X	
June 19, 1998	62.6	X	
July 2, 1998	62.6	X	
July 6, 1998	62.6	X	
July 15, 1998	62.5	X	
July 17, 1998	62.5	X	
July 22, 1998	62.5	X	
July 28, 1998	62.5	X	
July 29, 1998	62.5	X	
August 5, 1998	62.5	X	
August 12, 1998	62.5	X	
August 13, 1998	62.5	X	
August 18, 1998	62.5	X	
August 27, 1998	62.5	X	
September 3, 1998	62.5	X	
September 10, 1998	Not located	X	

Appendix B-17. Movements of Fish 361 from April 16 to June 22, 1998.

Date	Location (rkm)	Surface survey	Aerial survey
April 16, 1998	65.0	X	
April 17, 1998	64.4	X	
April 18, 1998	64.5	X	
April 20 1998	64.5	X	
April 21, 1998	64.5	X	
April 22, 1998	64.5	X	
April 24, 1998	64.1	X	
April 25, 1998	64.0	X	
April 28, 1998	63.5	X	
April 30, 1998	63.3	X	
May 1, 1998	63.3	X	
May 2, 1998	63.1	X	
May 3, 1998	63.0	X	
May 4, 1998	63.1	X	
May 5, 1998	63.1	X	
May 6, 1998	63.3	X	
May 7, 1998	63.6	X	
May 8, 1998	63.2	X	
May 11, 1998	63.0	X	
May 12, 1998	63.0	X	
May 13, 1998	62.8	X	
May 14, 1998	62.8	X	
May 20, 1998	63.5	X	
June 2, 1998	63.3	X	
June 17, 1998	62.9	X	
June 19, 1998	62.9	X	
June 22, 1998	62.9	X	
June 29, 1998	Not located	X	

Appendix B-18. Movements of Fish 381 from April 16 to August 12, 1998.

Date	Location (rkm)	Surface survey	Aerial survey
April 16, 1998	65.0	X	
April 17, 1998	64.1	X	
April 18, 1998	64.0	X	
April 20 1998	64.1	X	
April 21, 1998	64.0	X	
April 22, 1998	64.1	X	
April 24, 1998	64.3	X	
April 25, 1998	64.3	X	
April 28, 1998	63.8	X	
April 30, 1998	63.8	X	
May 1, 1998	63.1	X	
May 3, 1998	63.7	X	
May 4, 1998	63.5	X	
May 5, 1998	63.5	X	
May 6, 1998	63.5	X	
May 7, 1998	63.4	X	
May 8, 1998	63.2	X	
May 11, 1998	63.3	X	
May 12, 1998	63.4	X	
May 13, 1998	63.4	X	
May 14, 1998	62.9	X	
May 20, 1998	63.3	X	
May 26, 1998	63.3	X	
June 4, 1998	63.3	X	
July 15, 1998	63.3	X	
July 17, 1998	62.2	X	
July 22, 1998	63.2	X	
July 28, 1998	63.2	X	
July 29, 1998	63.2	X	
July 31, 1998	63.2	X	
August 5, 1998	63.2	X	
August 12, 1998	63.2	X	
August 13, 1998	Dropped transmitter	X	

Appendix B-19. Movements of Fish 401 from April 16 to October 8, 1998.

Date	Location (rkm)	Surface survey	Aerial survey
April 16, 1998	65.0	X	
April 17, 1998	64.8	X	
April 18, 1998	64.8	X	
April 20 1998	64.8	X	
April 21, 1998	64.8	X	
April 22, 1998	64.8	X	
April 24, 1998	64.8	X	
April 25, 1998	64.8	X	
April 28, 1998	64.8	X	
April 30, 1998	64.8	X	
May 1, 1998	64.8	X	
May 2, 1998	64.8	X	
May 3, 1998	64.8	X	
May 4, 1998	64.8	X	
May 5, 1998	64.8	X	
May 6, 1998	64.8	X	
May 7, 1998	64.8	X	
May 8, 1998	64.6	X	
May 11, 1998	64.8	X	
May 12, 1998	64.8	X	
May 13, 1998	64.8	X	
May 14, 1998	64.8	X	
June 4, 1998	60.2	X	
June 9, 1998	60.2	X	
July 2, 1998	59.7	X	
July 8, 1998	59.5	X	
July 13, 1998	59.2	X	
July 16, 1998	58.9	X	
July 22, 1998	59.1	X	
July 28, 1998	59.2	X	
July 29, 1998	59.2	X	
August 4, 1998	59.2	X	
August 12, 1998	59.2	X	
August 13, 1998	59.2	X	
August 18, 1998	59.1	X	
August 27, 1998	59.1	X	
September 3, 1998	59.1	X	
September 10, 1998	59.1	X	
September 17, 1998	59.1	X	
September 24, 1998	59.1	X	

Appendix B-19. Continued

Date	Location (rkm)	Surface survey	Aerial survey
October 1, 1998	59.1	X	
October 8, 1998	59.1	X	

Appendix B-20. Movements of Fish 421 from April 16 to May 13, 1998.

Date	Location (rkm)	Surface survey	Aerial survey
April 16, 1998	65.0	X	
April 17, 1998	65.1	X	
April 18, 1998	65.2	X	
April 20 1998	65.6	X	
April 21, 1998	65.5	X	
April 22, 1998	64.9	X	
April 24, 1998	64.4	X	
April 25, 1998	64.3	X	
April 28, 1998	Not located	X	
April 30, 1998	63.5	X	
May 1, 1998	63.4	X	
May 2, 1998	63.4	X	
May 3, 1998	63.5	X	
May 13, 1998	60.9	X	
May 14, 1998	Not located	X	

Appendix B-21. Movements of Fish 441 from April 16 to September 3, 1998.

Date	Location (rkm)	Surface survey	Aerial survey
April 16, 1998	65.0	X	
April 17, 1998	64.9	X	
April 18, 1998	65.1	X	
April 20 1998	65.0	X	
April 21, 1998	65.6	X	
April 22, 1998	65.6	X	
June 4, 1998	57.9	X	
June 5, 1998	57.9	X	
June 9, 1998	57.9	X	
July 2, 1998	57.9	X	
July 8, 1998	57.9	X	
July 13, 1998	58.0	X	
July 16, 1998	57.7	X	
July 22, 1998	57.7	X	
July 28, 1998	58.0	X	
July 29, 1998	58.0	X	
August 4, 1998	58.0	X	
August 12, 1998	58.0	X	
August 13, 1998	58.0	X	
August 18, 1998	58.0	X	
August 27, 1998	58.0	X	
September 3, 1998	58.0	X	
September 10, 1998	Dropped transmitter	X	

Appendix B-22. Movements of Fish 461 from April 16 to June 9, 1998.

Date	Location (rkm)	Surface survey	Aerial survey
April 16, 1998	65.0	X	
April 17, 1998	63.4	X	
May 8, 1998	54.0	X	
June 9, 1998	53.5	X	
June 17, 1998	Dropped transmitter	X	

Appendix B-23. Movements of Fish 481 from April 16 to October 8, 1998.

Date	Location (rkm)	Surface survey	Aerial survey
April 16, 1998	65.0	X	
April 17, 1998	63.3	X	
April 18, 1998	63.5	X	
April 21, 1998	62.5	X	
April 22, 1998	62.5	X	
April 24, 1998	62.5	X	
April 25, 1998	62.5	X	
May 2, 1998	62.8	X	
May 3, 1998	62.5	X	
May 4, 1998	62.5	X	
May 6, 1998	62.5	X	
May 7, 1998	62.5	X	
May 14, 1998	62.8	X	
May 18, 1998	62.7	X	
June 2, 1998	62.7	X	
June 9, 1998	62.7	X	
June 29, 1998	62.7	X	
July 6, 1998	62.7	X	
July 15, 1998	62.7	X	
July 17, 1998	62.7	X	
July 22, 1998	62.7	X	
July 28, 1998	62.7	X	
July 29, 1998	62.7	X	
August 5, 1998	62.7	X	
August 12, 1998	62.7	X	
August 13, 1998	62.7	X	
August 18, 1998	62.7	X	
August 27, 1998	62.7	X	
September 3, 1998	62.7	X	
September 10, 1998	62.7	X	
September 17, 1998	62.7	X	
September 24, 1998	62.7	X	
October 1, 1998	62.7	X	
October 8, 1998	62.7	X	

Appendix B-24. Movements of Fish 501 from April 16 to June 29, 1998.

Date	Location (rkm)	Surface survey	Aerial survey
April 16, 1998	65.0	X	
April 17, 1998	63.0	X	
April 18, 1998	63.1	X	
April 21, 1998	63.2	X	
April 22, 1998	63.2	X	
April 24, 1998	63.2	X	
April 25, 1998	63.2	X	
May 8, 1998	56.7	X	
May 13, 1998	56.7	X	
May 26, 1998	56.1	X	
June 2, 1998	56.2	X	
June 9, 1998	56.2	X	
June 29, 1998	56.2	X	
July 2, 1998	Dropped transmitter	X	

Appendix B-25. Movements of Fish 521 from April 16 to July 15, 1998.

Date	Location (rkm)	Surface survey	Aerial survey
April 16, 1998	65.0	X	
April 17, 1998	65.3	X	
April 18, 1998	65.4	X	
April 20, 1998	65.4	X	
April 21, 1998	65.0	X	
April 22, 1998	65.2	X	
April 24, 1998	63.0	X	
April 25, 1998	63.6	X	
July 8, 1998	63.6	X	
July 13, 1998	63.7	X	
July 15, 1998	Not located	X	